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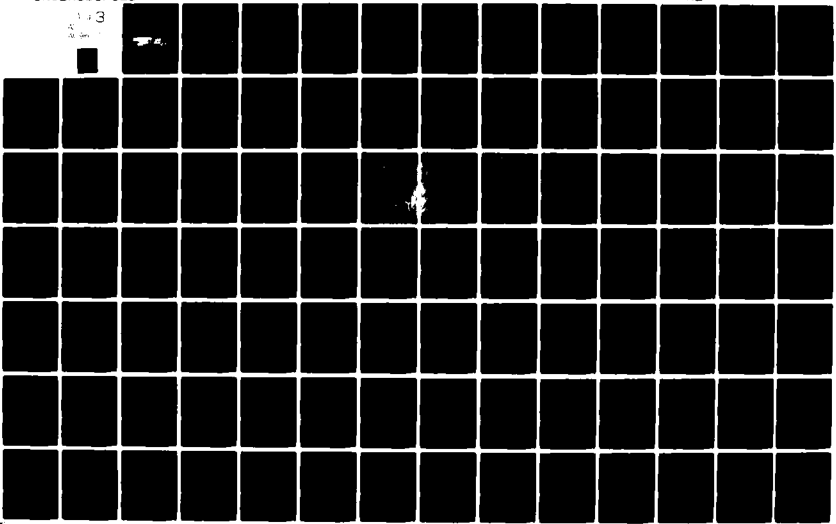

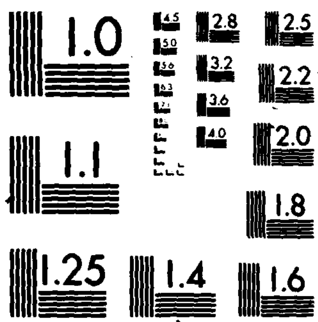

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ENVIRONMENTAL AND CULTURAL IMPACT

PROPOSED TENNESSEE COLONY RESERVOIR

JAN. 1972

TRINITY RIVER, TEXAS

by

STEPHEN F. AUSTIN STATE UNIVERSITY
Nacogdoches, Texas

(12)

BOTANY	EUTROPHICATION	LAND USE
ZOOLOGY	PESTICIDES	HISTORY
GEOLOGY	HYDROLOGY	ARCHAEOLOGY

VOLUME II
APPENDICES A, B, AND C

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This is an interim report of the study concerned with environmental and cultural impacts of the proposed channelization of the Trinity River. This publication presents data concerning the environmental impact of the proposed Tennessee Colony Reservoir. This interim report consists of five volumes: volume one contains the summary report; Volume two contains archaeological and historical elements, geological elements, and botanical elements; volume three contains zoological elements and eutrophication and pesticide elements; volume four contains forest hydrological and soil conditions for watershed

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20. management; and, volume five contains conceptual land use elements.

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APPENDIX A

HISTORICAL AND ARCHAEOLOGICAL ELEMENTS

of the

Proposed

TENNESSEE COLONY RESERVOIR

by

C. K. Chamberlain

The Historical Significance of the Proposed Tennessee Colony Dam

One of the disappointments that the first Europeans experienced on coming to Texas was the lack of water transportation. The Texas rivers were far apart, crooked, full of snags, and subject to droughts. The lower courses of the East Texas rivers were nevertheless used by small river steamboats in the early 1830's. Further inland enterprising settlers in the early period built rafts and after the crops were gathered, and the rains came they floated their cotton, hides, and other produce to the Gulf markets, sold their rafts for scrap lumber and got back home the best way they could. Often horses were purchased to be used on the return trip, and afterward on the farm. Each year, however, the river steamers ventured further up the river.

The rivers in Texas flow, as a general rule, to the southeast, and the Trinity is no exception. The East Fork, Elm Fork, the West Fork and the Clear Forks of the Trinity rise in Grayson, Montague, Archer and Parker counties. The main stream begins with the junction of the Elm and West Forks at Dallas. Fort Worth is on the West Fork. The Trinity is some 550 miles in length and its

drainage area is almost 1800 square miles. Its flow of 5,800,000 acre-feet near its mouth on the Gulf of Mexico is exceeded only by the Sabine, the Neches and the Red River basins. The Trinity River Valley with Fort Worth and Dallas near its sources and Houston near its mouth, supports a larger population and has a greater industrial development than any other river basin in Texas.

Spaniards such as Alvarez de Pineda, Cabaza de Vaca, Francisco Vasquez de Coronada and others had mapped the Coast of Texas, and explored some in the interior by the middle of the sixteenth century. The Spanish showed little interest in making settlements in Texas, but they claimed what is now the Southwestern and Western United States and the Gulf of Mexico. Some six months after La Salle landed at Matagorda Bay and built Fort St. Louis, the Spanish learned that the French were in the area and fitted out a number of expeditions to find the French and expel them from Spanish territory. On his fourth expedition in Texas looking for the French, Governor Alonso de Leon, on April 22, 1689, discovered the ruins of Fort St. Louis and learned of the massacre of the French by Karankawas. Although the immediate threat of the French had been removed, the Spanish realized that their claims to Texas would be in dispute until they made permanent settlements. On his return to Mexico de Leon reported to

the viceroy that Texas had good soil, a satisfactory climate and that the East Texas Indians were as civilized as the Aztecs and that the country could no longer be neglected. The Spanish churchmen were also eager to take the Christian religion to the East Texas Indians. Father Damian Massanet who had accompanied de Leon had met the Tejas chief and had made a friend of him. The chief asked for missionaries and Massanet promised to return. The Viceroy of Mexico, the Count of Galve, agreed to support an expedition to East Texas and the expedition left Monclova late in March 1690. The expedition consisted of Father Massanet and three other priests, and more than one hundred soldiers under de Leon. The Tejas chief and fourteen Indians met the Spanish party somewhere on the Trinity on May 22, 1690 and de Leon named the river La Santisima Trinidad (The Most Holy River). De Leon's expedition continued east and established the mission San Francisco de los Tejas near present day Weches in Houston County. Tradition has it that the Spanish, probably in 1690, established a mission, that existed for an even shorter time than San Francisco de los Tejas, on the Trinity in present day Anderson County.

The Trinity, usually a placid stream but a demon in flood stage, is a typical East Texas river. During the early days of Anglo-American settlements some colonization took place on the Trinity. Because of the need for trans-

portation the river stirred the imagination of many early settlers, and in 1849 a meeting was held in Huntsville for the purpose of encouraging steamboat traffic on the river. In 1852, Congress authorized a survey from Trinity Bay to Magnolia Ferry in Anderson County. The report, made in 1853, found the Trinity the deepest and less obstructed of any river in Texas. A second survey was authorized by Congress in 1872. In 1873, during the administration of Governor Edmund J. Davis, the Texas Legislature granted a subsidy of 10,000 acres per mile to Captain Poitevant if he could clear the river. He removed timber and snags up to Magnolia and received payment in land.

From 1862 to 1874 some fifty boats operated on the Trinity. Some of the boats went regularly as far as Kaufman and Ellis Counties, and a few reached Dallas. The Civil War, and the development of the railroad, which was more dependable than river transportation, brought a lack of interest in river transportation. Some individuals, however, could not forget the possibilities of the Trinity and for many years there has been a basin wide movement for navigation, conservation, and utilization of its waters. The Trinity Navigation Improvement Association in 1891 launched a steamboat sixty-four feet long named <u>Dallas</u> which plied the Trinity hauling cross-ties and barrel staves. In the meantime, Congress had authorized the building of several

locks and dams along the river and in 1914 a dam and lock were constructed west of Crockett by the United States Corps of Engineers. World War I halted the program, and after the war Congress refused to vote the money to continue the project and in 1921 the partially completed Trinity Basin program was abandoned.

John W. Carpenter of Dallas, and Amon G. Carter, of Fort Worth, organized the Trinity River Association which was dedicated to achieve barge traffic on the Trinity to Dallas and Fort Worth. In 1936, the association sponsored the establishment of the Trinity Watershed Soil Conservation and Flood Control Association. This was merged with the Trinity River Canal Association to form the new Trinity Improvement Association. The Trinity Improvement Association was organized to coordinate the program of improvement for the entire watershed. The association in 1937, financed a barge traffic and engineering study. In 1939, the United States Engineering Corps completed the study and recommended certain flood control projects. The Corps, also, approved the possibility of naviagtion up the river to Fort Worth. In 1941, a War Department survey recommended a number of dams near Dallas, and in 1945, at the end of World War II, Congress authorized the recommended projects. Several were completed by 1954. In 1955, the Trinity

Improvement Association sponsored, and the Legislature created, the Trinity River Authority, and a new study of the economic and navigation possibilities of the river was compiled in 1957.

In 1958, the Trinity River Authority completed a master plan and submitted it to the Texas State Board of Water Engineers. Congress, in 1958, directed the U. S. Corps of Engineers to make a comprehensive survey of the Trinity and the four year survey was begun in 1959. In 1959, the Trinity River Authority's first pollution control project was completed at a cost of seven million dollars. This project was to serve Grand Prairie, Irving, Farmers Branch, and Dallas. In the early 1960's, agreements were reached for dams in Navarro and Ellis counties and with the city of Houston on the development of Lake Livingston. In 1962, the Engineer's resurvey was completed, and Congress on October 20, 1965, adopted the Public Works Omnibus Authorization Bill which included funds for a continued study of the Trinity, and President Johnson signed the bill on October 26, 1965. In 1972, one hundred and twenty three years after the Huntsville meeting to improve navigation on the Trinity, the Trinity Barge Canal is near a reality.

In 1847, T. W. Davis built a flat boat and launched it

at what later became known as Magnolia in Anderson County. After the successful trip down the river from such a distance upland, a new concept of the importance of the Trinity led to the 1849 meeting in Huntsville. Magnolia on the left bank of the river immediately became an important shipping center. The first ferry authorized in Anderson County was issued to John Shipler in 1847, which enabled Magnolia to serve both sides of the river. In 1851, Magnolia was called the "little St. Louis on the Trinity," and the wealthy Adolphus Stern, a Nacogdoches businessman after a visit, wrote in his diary for March 7, 1851, that Magnolia was likely to become the most important river port on the Trinity, as Shreveport was on the Red River. The Trinity could be used for navigation only when the river was on a rise, and it is said at times as many as five thousands bales of cotton would be on the Manolia grounds waiting for the boats to come up the river. In 1863, Magnolia reached its peak as steamers began going further up the river and Bonner's Ferry and Wildcat Ferry were established up the river. In 1868 a riverboat reached Dallas. As the steamers went up the river other river ports were established all on the high or left bank. Although the railroads assumed most of the traffic to the Gulf, Cox's Bluff some two miles south of Cayuga was used as a port until the 1890's, as was Lindsey's Bluff a few

hundred yards up the river from Cox's Bluff. Neither Cox's Bluff nor Lindsey's Bluff were ferries because of the swamp lands on the right bank of the river, hence they were not as important shipping points as was Magnolia or Wildcat Ferry. Wildcat Ferry, some three or four miles up the river from Cayuga, was one of the most popular ferries on the entire Trinity. The old Fosterville Road from the east, and the Frontier Road from the southeast join at the ferry. When the river was at flood stage travelers sometimes had to camp at the ferry for weeks before they could cross. So many people camped and for such extended times, that a cemetery was necessary to take care of the dead. No local people were buried in the cemetery and the last burial was a transient woman and her infant in the 1890's. There are no marked graves. Cox's Bluff, Lindsey's Bluff and Wildcat Ferry, along with the Wildcat Ferry Cemetery, will not be inundated by the proposed lake.

Several sites have been suggested for the proposed dam in Anderson and Freestone Counties: at Tucker, Harmony, Tennessee Colony Alternate One and Tennessee Alternate Two. Anderson county was organized in 1846 and Freestone county was organized in 1851. At the present time, early 1972, it may be assumed that the dam will be constructed at Tennessee Colony Alternate Two. The proposed dam at Tennessee Colony has been called the "Big Bucket," because the dam

will be below the confluence of all the upper Trinity tributaries.

Tennessee Colony, fifteen miles west of Palestine and some five miles from the river, dates back to 1833, when Manuel Riondo received a grant of land from the Governor of Coahuila. Riondo employed James Zacheries and William Moore as his agents to bring colonists from the United States, and their first colonists came from Tennessee and Alabama and the colony was organized in 1838. Some descendants of the first colonists still live in the area. Beaver Creek, Catfish Creek, and Keechie Creek all drain the Tennessee Colony area, and long before the Anglos came, the Spanish and the Indians had skirmished over the area.

Soon a general store, a furniture store and a blacksmith shop were established. Corn, cotton, and sugar cane became the chief products. After riverboats reached Anderson County, cotton became the principal money crop for it could be sent down the river to the Gulf markets. In the 1840's, Tennessee Colony became an important shipping and trading center that extended perhaps as far north as the Dallas area. Raw products such as cotton and hides would be brought to the colony and exchanged for manufactured goods which had been brought up the river. So many merchants and traders came that an outstanding hotel was built to accomodate them.

Tennessee Colony has an interesting history. The first whiskey sold in Anderson County was sold there, and it was also the first community in the county to vote dry; the first baseball team organized in the county was at Tennessee Colony; the colony has experienced a slave insurrection; an oil boom; and has had the honor to be selected as a model community. The lake formed by dam site "number two" will have no ill effect on the colony; but in all probability will encourage many people to move into the community.

In this research a banker in Palestine, Cam Woolverton, is the only individual contacted who objected to site number two, and he informed the writer he had written to the Corps of Engineers, stating his objections and suggested that the writer do the same. An argument for dam site number two is that it will inundate only about 5,000 acres of the 22,000 acre Coffield State Prison Farm. The state, in purchasing the farm, knew some of the land would probably be under water and there are no objections.

Dam site alternate number two will have no ill effect on Sand Pond and Catfish Slough which are unusual in the ecology of the Trinity River Basin. This nine hundred acre area along Catfish Creek is a summer nesting place for thousands of egrets, herons, ibis, and other water birds. Whooping cranes drop in occasionally and in the winter the ducks move in. The property is owned by thirteen families compri-

sing the membership of the Sand Pond Hunting and Fishing Club.

A hardwood area near Sand Pond, which has been called "the Indian playground" will not be under water if dam site number two is selected as the place for the dam.

The Gus Engeling Wildlife Management area will not lose any land if the dam is placed at alternate number two. George Vetito, manager of the area, thinks the only effect the dam may have is that many people may come into the area as a result of the lake, and thus indirectly, wildlife on the area may be influenced.

Yard, some ten miles west of Tennessee Colony and north of Coffield Prison Farm, is a black community, and indications are that some parts of the community will be inundated. The history of Yard goes back to at least 1862 when the Cook family settled in the community bringing their slaves with them. No one seems to know how Yard got its name. It has been suggested that it was called Yard because it was a yard long and a yard wide. At one time Yard had two stores and a post office. Peter Gray and Bruce Gray, blacks, were each postmasters. Bruce followed Peter. The stores and post office have long since disappeared. The nearest business today is at Cook's Store which is about four miles east of Yard. Farm Roads 321 and 2706 merge at Cook's Store. The store is owned, in

1972, by Mrs. Gladys Boyd who is anticipating a good business if the lake becomes a reality.

Yard is aneat stock-raising community of black property owners. However, the large bodies of land are owned by whites. Some land purchases have been made in the last few years and must have been made with the knowledge that some of the land would be under water should the lake be constructed. There are several cemeteries in the Tennessee Colony and Yard communities. Two cemeteries used by blacks are on the prison farm and will not be under water. A very old cemetery, the Winn Cemetery, is about three-fourths of a mile from the river and when the river is at flood stage water comes within about five hundred yards of the cemetery. Winn Cemetery consists of several acres and contains many graves, some with headstones and many without any identification. Many old grave sites are entirely obliterated. The cemetery is not used at the present but the people are concerned about the cemetery. There are other cemeteries in the vicinity of Cook's Store, Bethel and Cayuga but noe are in danger of inundation.

Water from the proposed lake will inundate some good ranch land on both sides of the river. The present Derden Estate on the left bank will lose about one-third of its land. On the Ninerenpy Ranch some two miles south of Cayuga are several oil wells that will be under water, but it

is said the wells will be completely drained of oil in five years. The Getty Oil Company owns the oil field at the present time. The Cayuga oil field extends across the river into Freestone County but again the wells are exhausted or will be soon. The oil companies have long since destroyed all the timber in the fields. In Freestone County, and near the oil field, are some gas producing wells that may be effected by the lake. The 7 to 11 Ranch with headquarters near Wildcat Ferry, will lose most of its land. The Thornton Ranch is about four miles north of Wildcat Ferry, and west of the Cross Roads Community and consists of about 150 acres of gravel that may be very valuable. Cement sand is also found in the same area. This was the river bed at one time. The Kenebrew Ranch which joins the Thornton Ranch on the north, has a gravel pit in operation which is said to be a profitable business.

A levee has been constructed on the left bank of the river from Wildcat Ferry to Trinidad which will prevent some lands from being flooded.

Stephens Lake between Cross Roads and Trinidad, a private club, will probably be under water as well as County Park and Greslen Lake near Trinidad. Blue Mountain quarry in Freestone County is below the proposed dam and will not be affected by the lake.

The Industrial Generator Company, Big Brown Division, is being constructed some nine miles northeast of Fairfield and about three miles west of the Trinity. This plant will generate electricity through the use of lignite and it is said the lignite in the area will enable the plant to continue in operation for some thirty years. Some lignite beds will be inundated by the proposed lake but the company is aware of this fact and when construction begins on the dam the company will move its machinery, and mine the beds that will be under water. Across the river at Green's Bluff, near Yard, there is also evidences of lignite beds.

On the right bank of the river, and north of the Industrial Generator Company, and near the prison farm is the old Tyres Farm and Ferry and Cemetery. The cemetery is high enough that there is no danger of it being flooded. Sand Town Springs, an old settlement that has disappeared and the Sand Town Cemetery are on a hill. There are a few tombstones in this cemetery.

As mentioned earlier, the gas wells along the Tehuacana Creek east of Highway 488 may be flooded by back water from the lake. Between Kerens and Highway 287 and east of Highway 309 the Ingraham Cemetery is in no danger of being inundated. Rural Shade is also east of Highway 309 but few if any people live in the community. There is

nothing of historical interest near Rural Shade.

The more nomadic Indians of Central Texas who came to the Trinity to hunt and fish did not establish what might be called permanent camps. They lived at a site for a time and then moved on. Hence there is little evidence of permanent camps in Freestone County.

For many years the Trinity served somewhat as a boundary between war inclined Indians of Central and West Texas and the more peaceful East Texas Indians. Several different Indian tribes hunted and fished up and down both sides of the river. So for as Anderson County is concerned, and adjacent counties north, south, and east, the most prominent tribes were the Cherokees, Shawnees, Kickapoos, Delawares, Caddoes, Ionis, and the Anadarkoes. The East Texas Indians had permanent places of residence and did small scale farming. These permanent camp sites were along streams or near springs that served as the source of a stream. The permanent camps were above the floodstage of the river and creeks. It was natural for the Indians to hunt and fish up and down the river, for some of the best hunting and fishing grounds were in the bottoms that are subject to overflow. Indian skeletons have been found in a number of places up and down the river. Some deaths perhaps occurred because of an accident, some because of an enemy. If the river remains as it is and dams built,

artifacts will continue to be found for many years on both sides of the river. A possible permanent Indian camp is on a ridge about one hundred yards east of Cox's Bluff. It is said that a great number of arrow heads and other evidence of a permanent camp, including an Indian cemetery, have been found at this site. The Indians sought soft sandy land as burial sites and that type of soil was found at Cox's Bluff. This camp was not subject to overflow and will not be under water because of the proposed dam.

Near Trinidad and below the dam on Cedar Creek Reservoir and the river, a flood in 1941 washed out part of the levee and exposed, it is said, bushels of artifacts. The area is subject to flood and was not a permanent camp, but may have been a semi-permanent camp or it may have been a battle site. At any rate the site should be gone over carefully before being permanently inundated. Near the river bridge on Highway 31 and on the left river bank there is also evidence of an Indian Cemetery and permanent camp site. This will not be under water. Across the river in Navarro County in the Daniel Lake area there also is evidence of a semi-permanent camp, for many different types of Indian artifacts have been found. It is possible that Indians occupied the Daniel Lake site for many hundreds of years, for artifacts have been found which show a lower and higher

culture. On the other hand the Indians may have specialized; some may have made crude instruments that were passed on to others to be made into finished products and were lost in the exchange. The Daniel Lake area could only have been a semi-permanent camp for it is subject to overflow. When the floods came the campsite must have been moved to Rifle Ridge and when the water fell then back to Daniel Lake. Rifle Ridge affords a magnificent view of the river when it is at flood stage. The Daniel Lake area will probably be inundated and should be gone over by archaeologists.

In the Daniel Lake area and near Rifle Ridge in Navarro County, and on a peninsula on Indian Creek a tributary of Rush Creek, are a number of champion trees. These trees will probably be under high water. The trees can withstand ten to twelve weeks under water at the most, and if a system of locks is installed in the canal the trees will probably not be injured. Otherwise, according to Theo Daniel III they will be cut down.

Green's Bluff, west of Yard, will give a magnificent view of the lake and could be made into a recreation area. Another possible recreation site is on the Ninerenpy Ranch south of Cayuga where Indian Camp Creek will run into the lake. The lake at Indian Camp Creek will probably be five or six miles wide and the land is a sandy loam that will

support a marina and lake houses. The lake will also be four or five miles wide at Wildcat Creek on the 7 to 11 Ranch and there are also a number of possible recreation sites. One of the most imposing sites will be on the Joe Watham place. From this site miles of the lake can be seen.

RECOMMENDATIONS

Any project the size of the proposed dam at Tennessee Colony will have some bad results. A great deal of good ranch land on both sides of the river will be inundated. The Winn Cemetery at Yard will need to be moved. An area between Cedar Creek Reservoir and the Trinity, near Trinidad, as well as the area around Daniel Lake in Navarro County, will need to be gone over carefully for Indian artifacts before being covered with water.

Some gravel and sand beds north of Cayuga will probably be covered by the lake. The Industrial Generator Company will have some lignite beds inundated. Highway 287 will need to be raised, perhaps at Indian Camp Creek on the east side of the river, and for a mile or more on the west side of the river.

It has been difficult to find anyone in the region who opposed the dam if it is to be constructed at Tennessee Colony Alternate Two.

APPENDIX B

GEOLOGICAL ELEMENTS

by

HERSHEL L. JONES

with the
assistance of:

Don Anderson
Carey Crocker
Volker Göbel
Tom Middlebrook
Jerry Vincent

GEOLOGICAL STUDY OF THE TENNESSEE COLONY RESERVOIR AREA, EAST TEXAS

by: Hershel L. Jones

TABLE OF CONTENTS

	Page
INTRODUCTION AND SUMMARY	B - 1
INTRODUCTION	B - 4
GEOLOGICAL SETTING	B - 6
GEOLOGY OF THE SURVEY AREA	B - 8
GEOMORPHOLOGY	B - 8
STRATIGRAPHY	B - 9
STRUCTURE	B - 13
PALEONTOLOGY	B - 14
COMMERCIAL DEPOSITS OF ROCKS, MINERALS, OIL AND GAS	
Peat	B - 16
Sand and Gravel	B - 19
Clay	B - 22
Lignite	B - 24
Oil and Gas	B - 28
Salt	B - 28
GROUNDWATER	B - 33
GEOLOGICAL EFFECTS OF FLOODING	B - 36
IMMEDIATE EFFECTS	B - 36
Industrial Operations	B - 36
Geological localities	B - 38
LONG-RANGE EFFECTS	B - 39
Oil-field pollution	B - 39
Density Stratification	B - 41
Siltation	B - 42
Pollution by Lignite Utilization	B - 44

TABLE OF CONTENTS CONTINUED

Pollution by Gas Torching B - 45

Groundwater Changes B - 45

CONCLUSIONS B - 48

IMMEDIATE EFFECTS B - 48

LONG-RANGE EFFECTS B - 50

REFERENCES B - 54

LIST OF TABLES

Table		Page
B1.	Petrography of geological formations........	B - 10-11
B2.	Stratigraphy of the Midway Group, Paleocene, Tertiary; Lower Tehuacana Creek area........	B - 12
B3.	Paleontology of selected fossil localities..	B - 15
B4.	Lignite reserves of Freestone, Anderson, and Henderson Counties......................	B - 26
B5.	Oil and gas fields.........................	B - 31-32

LIST OF FIGURES

Figure		Page
B1.	A generalized geologic map, Tennessee Colony reservoir area, East Texas...........	B - 5
B2.	County Map. Position of counties in the survey area............................	B - 17
B3.	Areal extent of the Tennessee Colony Reservoir..................................	B - 18
B4.	Marsh and peat deposits......................	B - 20
B5.	Occurrence of sand and gravel deposits......	B - 21
B6.	Clay deposits...............................	B - 23
B7.	Lignite deposits of the Wilcox Group........	B - 25
B8.	Oil fields..................................	B - 29
B9.	Oil and gas pipelines.......................	B - 30
B10.	Extent of Carrizo - Wilcox aquifer..........	B - 34

INTRODUCTION AND SUMMARY

The geological investigation was conducted as part of the interdisciplinary study and covers the geological aspects related to the proposed channelization of the Trinity River.

The damming of the Trinity River northwest of Tennessee Colony will ultimately raise the water of the reservoir to the 292 foot contour line, approximately 62 feet above the present river level at the proposed dam site.

The creation of the lake causes flooding of the present alluvial plains of the Trinity River and its numerous tributaries. It will result in the inundation of:

Portions of existing field production and disposal facilities of the Cayuga, Stephens Lake, Bazette, Flag Lake, South Kerens, Carter-Cragg, and Stewards Mill oil and gas fields;

Gas and oil pipelines which are located in the valleys of the Trinity River and its tributaries;

Drinking water wells;

Potential gravel production areas in the Trinity River valley including a sand and gravel pit in operation near Turkey Creek, Henderson County;

The geologic type locality of the Kerens Member of the Wills Point Formation east of Kerens, Navarro County;

Several fossil localities along the cliff of the Trinity River northeast of Kerens;

Potential peat deposit areas in the flood plain of the Trinity River.

The inundation effects are associated with and followed by:

Possible pollution of the lake water by oil field brines and crude oil which are commonly retained by present practice in unlined sludge pits or are discharged onto the ground and into creeks. Contamination of the lake water by brines results in a considerable increase in the water salinity. Density stratification of the water is possible, the denser saline water forming the lower water layer in the lake basin which causes anaerobic, toxic conditions. Salinity causes also an increase in flocculation and sedimentation of clay minerals. Oil has harmful effects on plant and animal life, and causes pollution of the shoreline areas.

The overall decrease in water quality requires extensive purification for drinking water production, and occasional flushing of the reservoir which, however, may have harmful effects downstream.

The discharge of sediments by the tributaries into the shallow-water subbasins causes their progressive silting-up which is also promoted by the possible increased salinity of the lake water.

Excessive water seepage in the fault zone intersecting the northern most part of the reservoir will probably not take place.

Lignite is strip-mined on a large scale north of Fairfield, Freestone County, and will be used for electric power generation in the new Big Brown Steam Electric Station northeast of Fairfield. Apparently, sulfur dioxide gas and possible mercury vapor will not be removed from the stack emissions. This results in a considerable sulfur dioxide and mercury concentration (?) in the discharge. Dispersal of the emissions by prevailing southwest-northeast winds results in adverse effects in the downwind areas including pasture land, the reservoir, and its drainage area. An increase in the acidity of the surface water is also possible.

The practice of burning undesirable amounts of sulfur-rich gas releases sulfur dioxide gas directly into the atmosphere.

Disposal of large amounts of channel excavation material could be accomplished by the building-up of shallow lake areas.

Gravel, sand, and clay deposits in the region could be utilized for construction purposes.

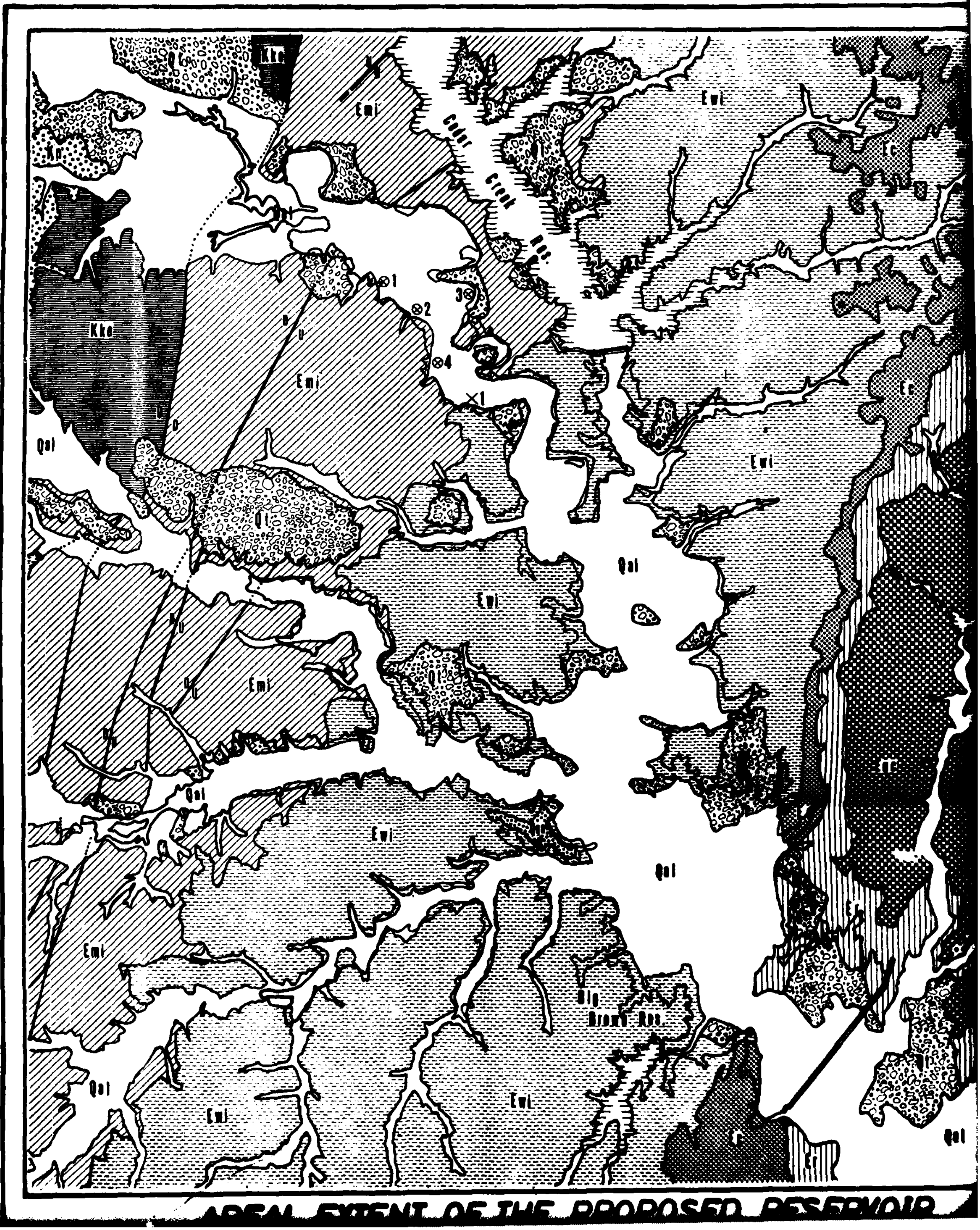
Aquifers occur in the major part of the Tennessee Colony area. The initial effect of the impoundment on these will be the reversal of the water table slope away from the reservoir. This reversal coupled with artificial recharge from the reservoir results in an increase in the water level in adjacent aquifers. Seepage and ponding is most likely to occur in the areas of Catfish Creek and the city of Trinidad.

INTRODUCTION

The report is the result of a geologic study of that portion of the Trinity River and its drainage basin which will be affected by the construction of a lock and dam near Tennessee Colony, Anderson County by the United States Army Corps of Engineers (Figure B1).

The geology and the impact of the channelization and damming within and adjacent to the proposed reservoir area were to be investigated. The geological conditions, the possible changes, and the related environmental aspects were studied.

The construction of the dam at the alternate 2A-dam-site will ultimately raise the reservoir water level to the 292-foot contour line, approximately 62 feet above the present flood plain at the proposed dam site. This will create a lake which will extend northward to the vicinity of the Cedar Creek Reservoir. The valleys of the tributary creeks will also be flooded for great distances upstream.



AREAL EXTENT OF THE PROPOSED RESERVOIR

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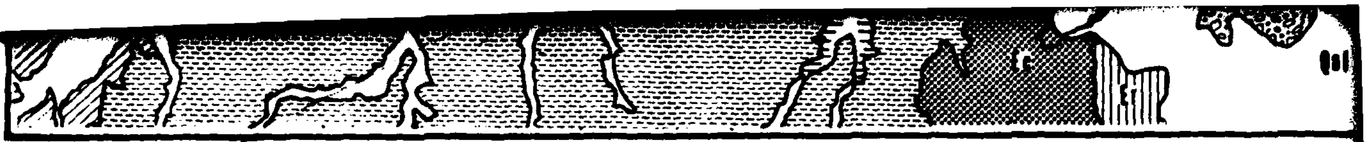

AREAL EXTENT OF THE PROPOSED RESERVOIR GENERALIZED GEOLOGIC MAP,

TENNESSEE COLONY RESERVOIR AREA, EAST TEXAS

N

LEGEND

QUATERNARY	Qal	ALLUVIUM	Clay, silt, sand, peat.	Minor aquifer
QUATERNARY	Qqa	QUARTZ ARENITE	Sand.	Minor aquifer
QUATERNARY	Qt	FLUVIAL TERRACE DEPOSITS	Gravel, sand, silt.	Minor aquifer
TERTIARY	Eqc	QUEEN CITY SAND	Sand.	Minor aquifer
TERTIARY	Er	REKLAW FORMATION	Clay, silt, sand.	Aquiclude
TERTIARY	Ec	CARRIZO SAND	Sand.	Major aquifer
TERTIARY	Ewi	WILCOX GROUP	Clay, silt, sand.	Major aquifer
TERTIARY	Emi	MIDWAY GROUP	Clay.	Aquiclude
CRETACEOUS	Kke	KEMP CLAY	Clay.	Aquiclude
CRETACEOUS	Kn	NACATOCH SAND	Sand.	Minor Aquifer

Contact; observed or located.

Fault; dashed were in dotted were concealed. U, upthrown side. D, downthrown side.

Type section

Fossil locality

Reservoir

Dam

Scale

0 miles 4

Geology compiled from Geologic Atlas of Texas.

B - 5

3

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Fig. B1

4

GEOLOGICAL SETTING

The survey region lies entirely within the Coastal Plain Physiographic Province, a more or less gently undulating plain bordering the Gulf of Mexico. Strata underlying the plain dip to the southeast at a slightly steeper angle than the present land surface. This results in a series of outcrop belts essentially parallel to the present coastline. Differential erosion of alternating resistant and less resistant rocks in this tilted sequence has produced a series of low, landward facing escarpments which break the gentle seaward slope of the land.

A generalized geological map is given in Figure B1.

Rocks exposed in the Trinity River drainage basin are of sedimentary origin. They consist of shales, sandstones, chalks, marles, and unconsolidated clastic sediments such as silt, sand, gravel, and range in age from Pennsylvanian to Quaternary. In the northwestern part of the basin the Upper Cretaceous rocks onlap uncomformably on older strata of Pennsylvanian age. The beds of Pennsylvanian age dip to the northwest while the successively younger Mesozoic and Cenozoic sediments dip to the southeast.

The formations exposed in the project area are entirely of Cretaceous, Tertiary, and Quaternary age. The oldest rocks exposed are Upper Cretaceous, and extend from the Dallas area to the Mexia-Talco fault zone which crosses the Trinity River northeast of the town of Corsicana.

Tertiary and younger formations extend from there on to the Gulf of Mexico.

The sediments in this western part of East Texas are positioned at the northwestern to western portion of a depositional basin referred to as the East Texas Embayment. Its axis and deepest part occur east of the survey area near Tyler. The axis strikes more or less in a north-south direction. The sediments dip consistently to the southeast into this basin. The thickness of the rock units commonly increases towards the basinal deep.

The uniformly dipping strata are disturbed at many places by numerous salt domes situated close to the basin axis, e. g. the Butler and Palestine domes in the vicinity of the survey area. The salt masses were mobilized from bedded salt deposits at greater depths (Louann Salt) and ascended through the overlying sediments. They displaced the country rock producing diapiric structures which frequently serve as oil and gas traps.

Major displacements of the sedimentary strata took place along abundant faults which dip to the northwest and the southeast. The faults form a system of en enchelon faults and grabens called the Mexia-Talco fault system. It trends along the western part of East Texas in a north-south direction and swings to an easterly direction in the northern part thus framing the East Texas Embayment.

GEOLOGY OF THE SURVEY AREA

GEOMORPHOLOGY

The survey area lies in the region of the East Texas timberland which is characterized by gently rolling topography with relief generally of 100 to 200 feet. It is drained by the Trinity River and its major tributaries which include Chambers, Richland, and Tehuacana Creeks. The flood plain of the Trinity River is approximately five miles wide and lies 150-200 feet lower than the surrounding area.

Quaternary stream terraces are found along the Trinity River and many of its tributaries.

STRATIGRAPHY

Rock formations outcropping in the area of the proposed reservoir and dam are Cretaceous to Recent in age. They consist predominantly of interlayered clay, silt, sand, gravel, and lignite beds.

A condensed petrographic description of the formations is given in Table B1 which lists the formations in an order which reflect their increasing age.

Detailed information about the stratigraphy of the Midway Group and the unique type section of the Kerens member of the Wills Point Formation is given in Table B2. Several fossil localities of the Kerens member occur in the northern part of the survey area. The type locality is situated on the western side of the Trinity River approximately 4.5 miles east of Kerens, Navarro County.

Table B1: Petrography of Geological Formations in the Survey Area.

Name	Petrography
QUATERNARY	
Alluvium	Flood plain deposits of clay, silt, sand, and minor gravel, with local peat deposits in bogs.
Quartz Arenite	Quartz sand: gray, weathers light gray. Loosely consolidated. Medium grained.
Fluviatile Terrace Deposits	Gravel, sand, and silt: in three terraces of the Trinity River and tributaries; 15 to 75 feet above the present flood plain level.
TERTIARY	
Queen City Sand	Quartz sand: light gray to brownish gray, weathers red-brown and white mottled. Commonly fine grained, also medium grained. Concretions. Loosely consolidated. Locally carbonaceous, lignitic, glauconitic, clay interbeds.
Reklaw Formation	Clay, with minor silt and sand: brownish black to brownish gray, weathers light brown to light gray. Laminated, also thin bedded, concretions. Carbonaceous, ferruginous, micaceous.
Carrizo Sand	Quartz sand, with some clay and silt interbedded: medium to dark gray, weathers reddish brown to light gray. Fine to medium grained, thin bedded to massive, locally cross-bedded, lossely consolidated. Partly carbonaceous, ferruginous, calcareous.

Table B1. Continued

Wilcox Group	Clay, also lignite, silt, quartz sand: gray, weathers gray, reddish brown, buff. Laminated to massive, locally cross-bedded, concretions. Silty, sandy, glauconitic, carbonaceous, ferrugineous, calcareous.
Midway Group	Clay, with minor silt, limestone, marl, lignite: various shades of gray, weathers medium gray. Laminated, thin bedded, locally massive. Silty, sand, clacareous, phosphatic, lignitic, selenitic.
CRETACEOUS	
Kemp Clay	Clay: dark to bluish gray, weathers black to greenish gray. Laminated, concretions. Silty, glauconitic, calcareous.
Nacatoch Sand	Quartz sand: gray, weathers light gray. Fine to coarse grained. Massive, also cross-bedded. Argillaceous, glauconitic, calcareous.

Table B2: Stratigraphy of the Midway Group, Paleocene, Tertiary; Lower Tehuacana Creek Area.

Formation Member	Approximate Thickness (in feet)	Petrography
WILLS POINT		
Solomon Creek	140'	Shales: gray, carbonaceous, interbedded with glauconitic, cross-bedded, quartz sands.
Kerens	290'	Shale: dark gray, contains large ironstone concretions.
Mexia	47'	Shale: dark gray
	33'	Sandy shale: fossiliferous.
	3'	Sand: glauconitic, with mollusk fragments, fish teeth, coprolites, abundant micro-fossils.
	83'	
KINCAID		
Tehuacana	35'	Shaly sand: glauconitic; sandy limestone.
Pisgah	75'	Sandy shale: gray, glauconitic.
	53'	Sandy shale: gray, glauconitic.
	20'	Sandy shale: gray.
Littig	7'	Sandy shale: dark green, with streaks of galuconitic sand, contains phosphate pebbles, mollusk fragments, fish teeth, coprolites. Uncomformably on Upper Cretaceous Navarro Formation.

STRUCTURE

Complex geological structures are not found in the area, however, structural deformation of the gently southeasterly dipping strata took place in the northwestern part of the survey area.

Numerous faults and grabens of the Mexia-Talco fault system cross Navarro, Henderson, and Van Zandt Counties. One graben structure intersects the Trinity River valley between Corsicana and the Cedar Creek reservoir. Sediments of the Midway Group are faulted against Cretaceous rocks. The faults of the system appear to be inactive. They are presently not exposed, and have apparently no significant expression in the area which will be submerged by the reservoir water.

The Bethel salt dome in Anderson County is the only, mushroom-shaped, diapir structure in the survey area. It serves as a structural trap for oil and gas.

PALEONTOLOGY

The sediments exposed contain remnants of plant and animal life.

Table B3 lists the outcrops and gives a description of the fossil content found. The lithology of the strata has already been discussed in preceding Table B2.

The fossil localities area are located on the generalized geologic map, Figure B1.

Table B3: Paleontology of Selected Fossil Localities.

Locality No.	Location	Geologic Formation	Fossil Content
1	Cliff west of Trinity River at Morgan Springs, 5 miles northeast of Bazett.	Wills Point	Mostly foraminifera, sparsely fossiliferous.
2	Cliff west of Trinity River at Rocky Bluff, 1.5 miles south of locality No. 1.	Wills Point	Mostly foraminifera, sparsely fossiliferous.
3	Cliff east of Trinity River at Burton's Bluff, directly across river from locality No. 2; 8.5 miles northwest of the town of Malakoff.	Wills Point	Only outcrop to yield Cornuspira Carinata, sparsely fossiliferous.
4	Cliff east of Trinity River at old bridge ruins, 2.3 miles south of locality No. 3.	Wills Point	Abundant fossil fragments.

COMMERCIAL DEPOSITS OF ROCKS, MINERALS, OIL AND GAS

Deposits of rocks, minerals, oil and gas are abundant in those parts of Freestone, Anderson, Henderson and Navarro Counties (Fig. B2) which are affected by the proposed dam and the lake generated (Fig. B3).

Several commercial deposits of oil and gas are exploited in the survey area, notably the Cayuga and Bethel oil and gas fields. Mining of lignite deposits was done near Malakoff in Henderson County. Lignite is currently being strip-mined in a new open-pit near Fairfield in Freestone County.

Terrace gravels are worked near Turkey Creek, Henderson County. In addition to the deposits exploited at the present time, commercially potential deposits of sand, clay, and lignite occur in the region which warrant further exploration. The recovery of those deposits is in part influenced by the damming of the Trinity River.

Peat

Peat is primarily used as soil conditioner in amounts of approximately 10,000 tons per year in Texas and must be imported from out-of state deposits. Peat deposits can be mined in small-scale operations which avoid costly, highly mechanized equipment.

Potential bogs containing peat occur in the marsh land of the flood plain of the Trinity River. The extent of the possible peat deposits and the amount of their

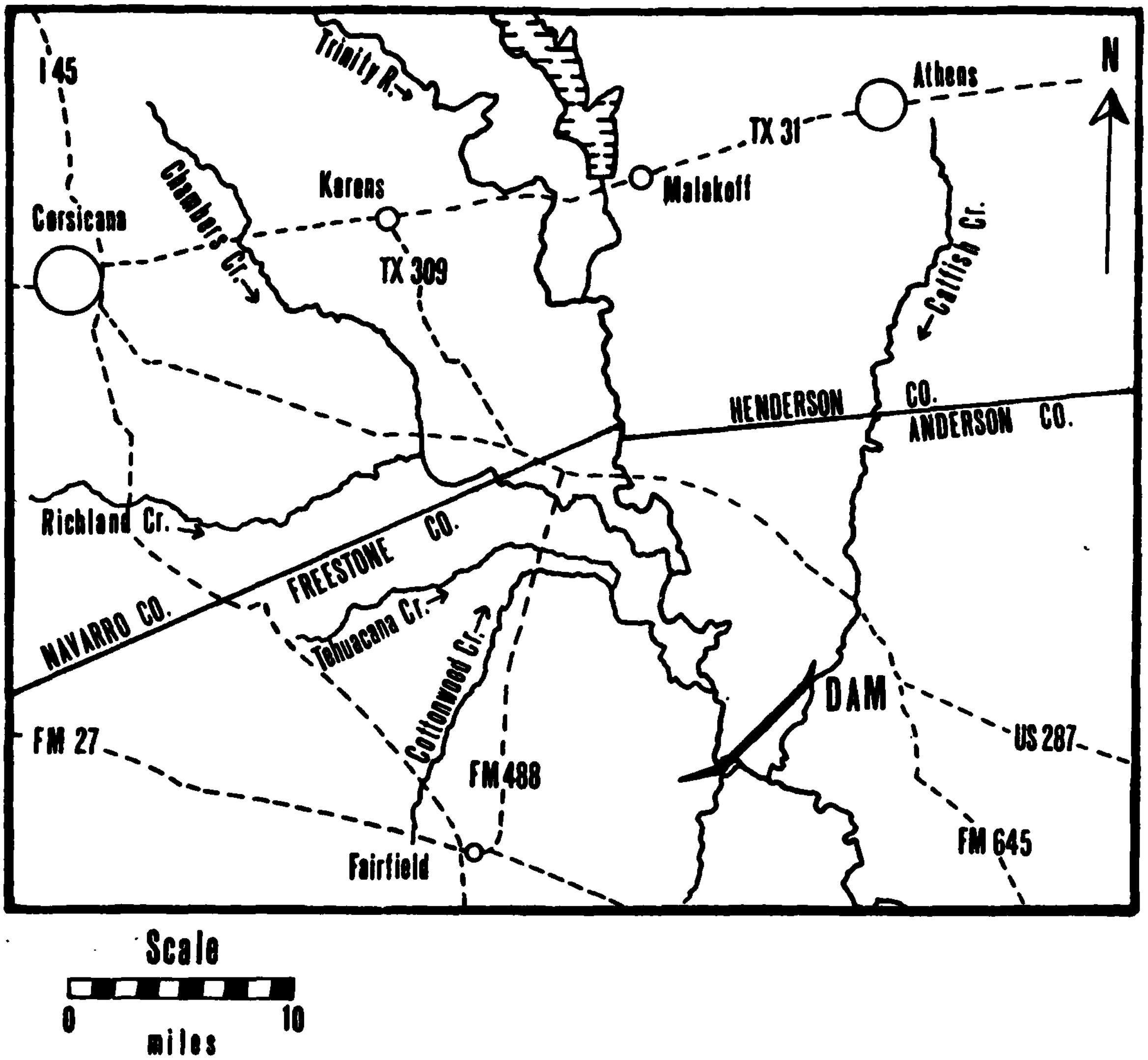

Figure B2: COUNTY MAP

The map shows the position of the four counties in the survey area (Navarro, Freestone, Anderson, and Henderson County). The Trinity River serves as a border between the western and the eastern counties.

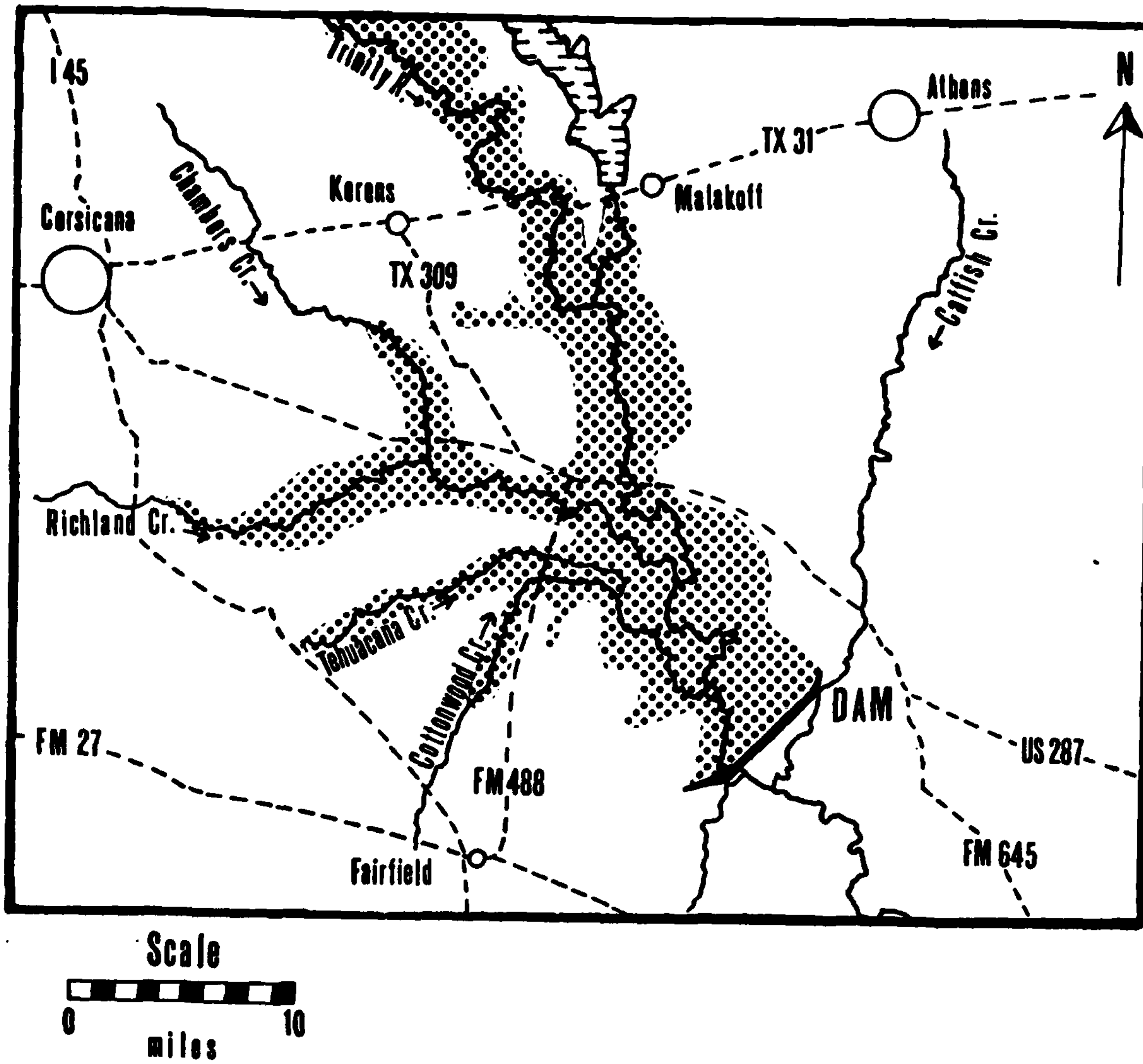

Figure B3: AREAL EXTENT OF TENNESSEE COLONY RESERVOIR

The artificial lake will cover the Trinity River's alluvial plain and large parts of the valleys of its tributaries.

reserves are not known at the moment (Fig. B4).

Sand and Gravel

Potential source areas for sand are the Turlington district west and southwest of the proposed dam and an elongate area north of the dam (Fig. B5). The northern area extends to the Athens district in Henderson County (Fig. B5) where small pits were operated in the past. With the exception of the Julian gravel pit in the vicinity of Turkey Creek, sands are not continuously produced in the survey area.

The source of the sand is the Carrizo Formation which yields a high quality, well sorted quartz sand. Sands of the Reklaw Formation and the Wilcox Group seem to be of lesser quality.

The area north of Edwards Creek in Freestone County appears to be of great potential for sand. Sand of the Wilcox Group from an area west of Bethel was used for the construction of the new truck road between the lignite mine and the Big Brown Steam Electric Station.

Gravel is presently worked at the Julian Gravel Pit in the neighborhood of Turkey Creek in the Trinity River valley. The gravel in the pit occurs under 15 to 20 feet of overburden. The company has leased 1200 acres, 700 acres of which have been drilled. Annually, up to 6 acres are mined. The average productive thickness is 18 feet.

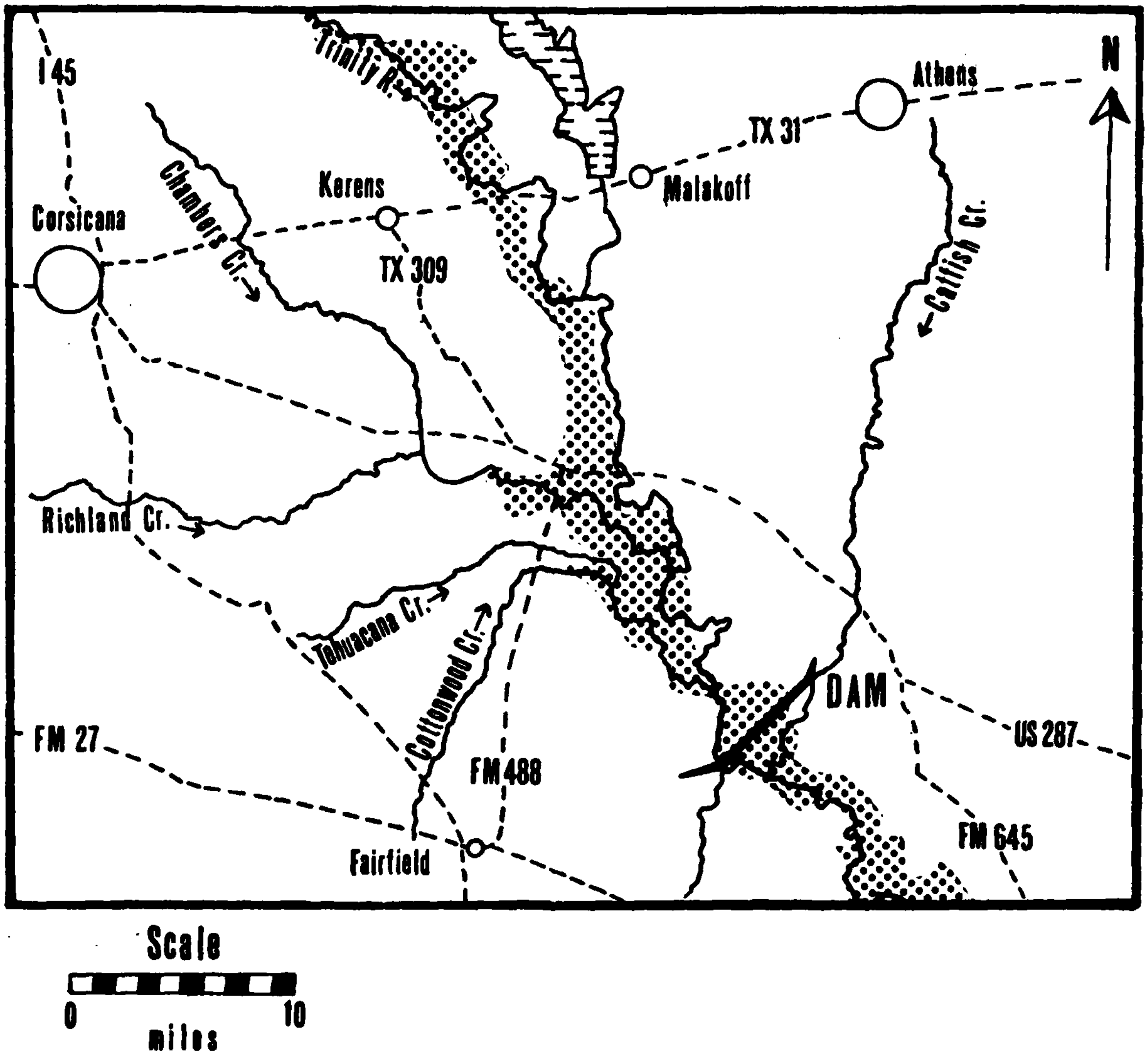

Figure B4: MARSH AND PEAT DEPOSITS

The illustration outlines the marsh land in the flood plain of the Trinity River. It is possible that bog areas contain economical peat deposits.

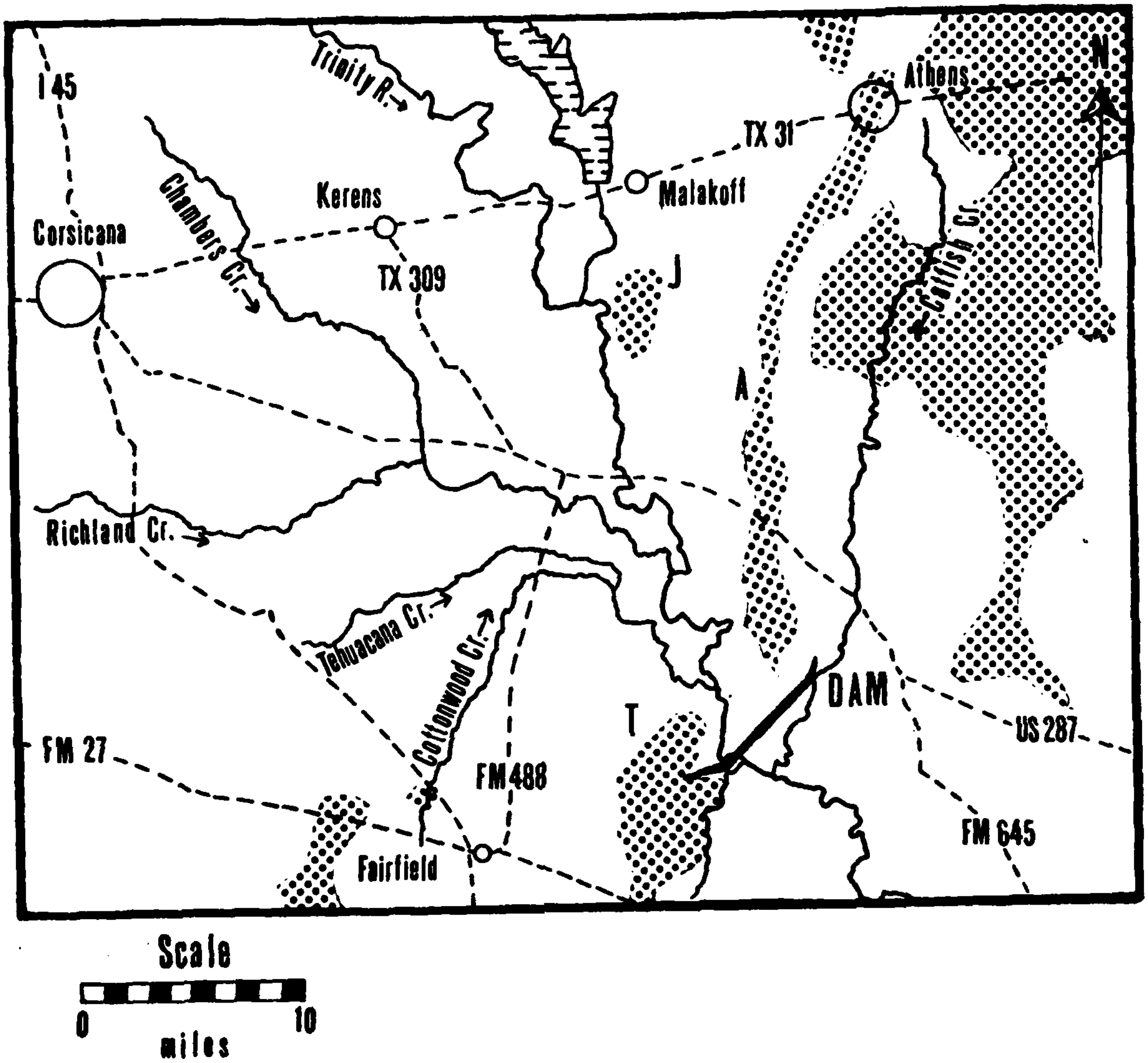

Figure B5: OCCURRENCE OF SAND AND GRAVEL DEPOSITS

The areas of industrial and constructional sand and gravel deposits are outlined:

T: Turlington district
A: Athens district
J: Julian gravel pit

Clay

In East Texas, portions of the Wilcox Group are a major source for ceramic and nonceramic clays. Clays, silt, and sand of the Wilcox Group cover large parts of the survey area and may contain commercial clay deposits (Fig. B6). Clay pits were occasionally operated in the survey area.

A number of clay analysis indicate the presence of expandable clay, drilling-mud clay, swelling clay, and activable bleaching clay in the vicinity of the Round Prairie-Young Community in Freestone County. Light-colored brick and structural clays were analyzed from deposits close to Farm Road 488 further to the north of this community. The clay is montmorillonite-rich and contains minor amounts of kaolinite (Fisher, 1965).

Clay occurrences in Henderson and Anderson Counties appear to be of minor importance at the present time. The clay reserves and the extent of potential deposits remain unknown.

Combined clay and lignite mining seems to be possible and most profitable because many clay beds occur above the lignite seams or they are interlayered with the coal beds.

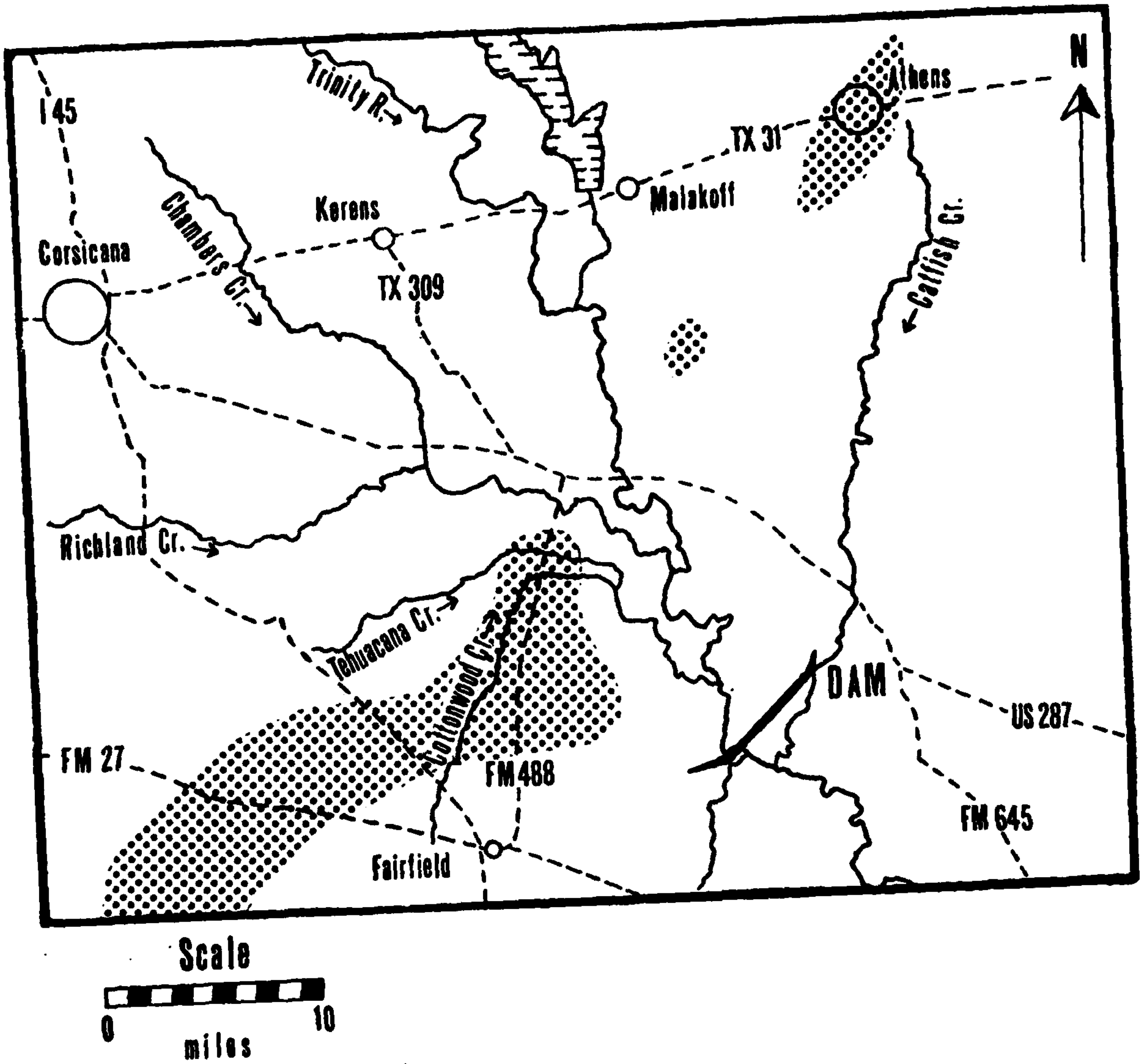

Figure B6: CLAY DEPOSITS

Potential deposits of clay occur in the marked area. The clay can be utilized for a variety of ceramic and non-ceramic purposes.

Lignite

Lignite, or brown coal, is low-rank coal which is widespread in East Texas and which was mined at several localities near Malakoff in Henderson County. It serves primarily as solid fuel for electric power generation and is, therefore, in direct competition with oil and gas. For this reason, only "mine-mouth" power plants are economically feasable where coal is recovered by open-pit strip-mining and directly utilized in the nearby power plant.

The regional geology and well drilling data indicate that a belt of lignite crosses the area (Fig. B7) from Malakoff in the western part of Henderson County to Fairfield in the central part of Freemont County. The lignite seams are present in the middle to upper parts of the Wilcox Group, notably in the lower part of the Calvert Bluff formation. The combined total thickness of the seams varies usually between 7 to 12 feet. Several seams with clay and silt partings are normally present. The stratigraphically higher seams are covered by approximately 30 to 50 feet of overburden. The lignite deposits of the belt are of high commercial potential with considerable reserves. Reserves for the entire areas of Freestone, Anderson, and Henderson Counties are listed in Table B4.

Lignite is mined on a large scale in a new strip-mine north of Fairfield east of Farm Road 2547. Future mining will extend in a northeasterly direction to Farm Road 488.

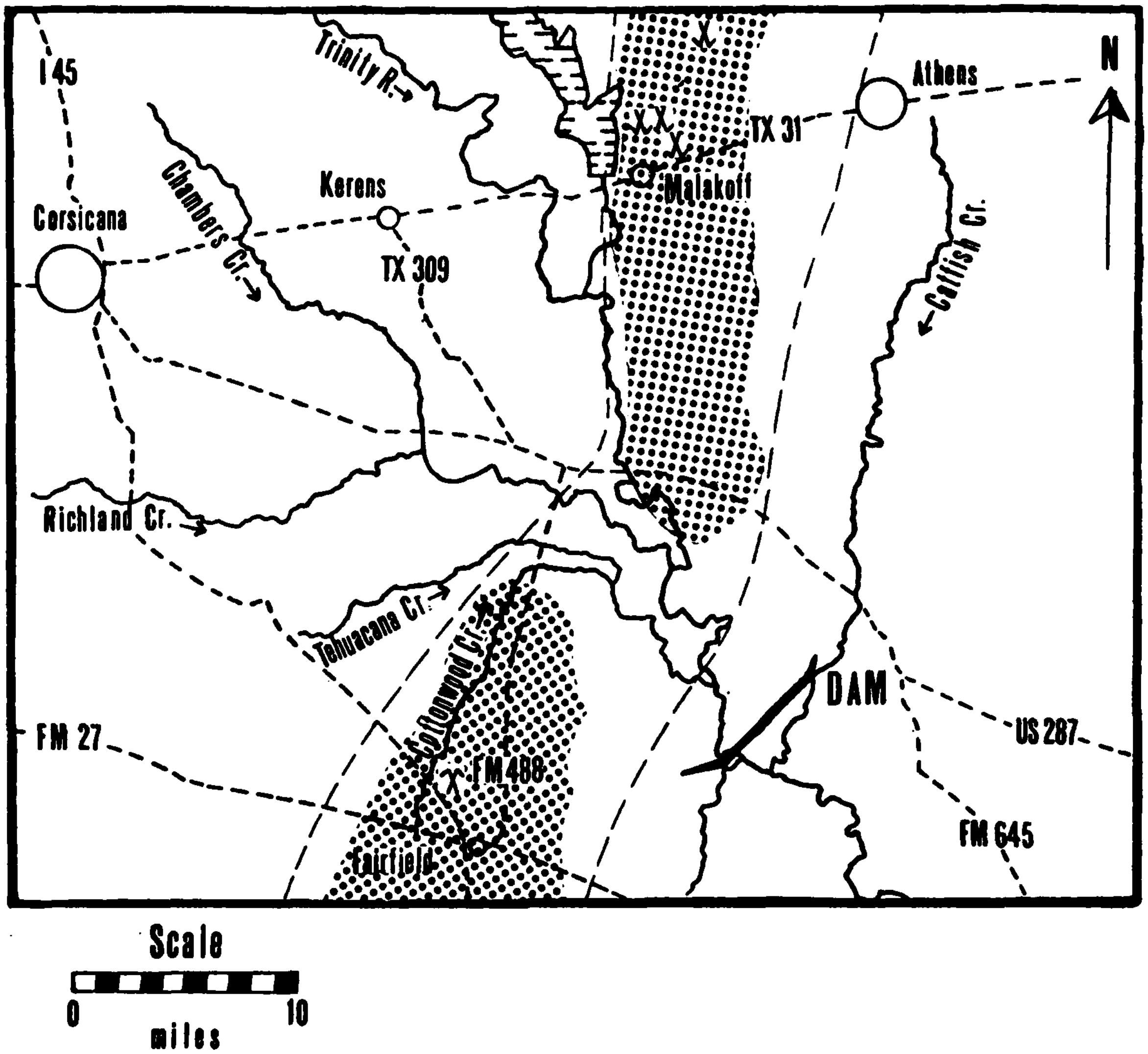

Figure B7: LIGNITE DEPOSITS OF THE WILCOX GROUP

The areas of principle lignite deposits lie within a north-south trending lignite belt. The lignite is currently mined near Fairfield, and was worked north of Malakoff.

⚒ , mine in operation

⚒ , mine, abandoned

Table B4: Lignite Reserves of Freestone, Anderson, and Henderson Counties. (Data modified after Fisher, 1965, p. 282).

County	Overburden (in feet)	Reserves (in million short tons) Estimated for Counties Measured	Indicated	Estimated for Survey Area Measured/Indicated
Freestone	< 90	25.5	76.5	8.0 / 25.0
	> 90	23.8	71.4	8.0 / 24.0
Anderson	< 90	21.4	64.2	21.0 / 64.0
	> 90	55.2	165.6	55.0 /165.0
Henderson	< 90	37.8	33.0	9.5 / 8.0
	> 90	113.4	99.0	28.0 / 25.0

The area consist of approximately 17,500 acres which will be mined in the next 35 years. Annual production will be about 1 million short tons. The lignite seams have an average thickness of 9 feet and occur under an average overburden of 38 feet. Sulfur content as given is supposedly 0.4 - 0.6 percent (THE DALLAS MORNING NEWS, 1971).

Lignites frequently contain appreciable amounts of mercury, however, analyical data for the deposit are not available at the present time.

The lignite is used as fuel in the nearby, newly constructed Big Brown Steam Electric Station at Big Brown Reservoir. It is operated by the Industrial Generating Company for Texas Power and Light, Texas Electric Service Company, and Dallas Power and Light Company. The plant is still in the assemblage and experimental stage.

Oil and Gas

Several oil and gas fields and pipelines occur in the survey area. They have produced in the past or are still production (Fig. B8, B9). They are discussed Table B5.

Salt

The Bethel salt dome in Anderson County (Fig. B8) is a potential source for rock salt. It also serves as a structural trap for oil and gas. Depth to the salt is 1500 feet. Because of its depth the deposit was not mined in the past and its salt reserves are unknown.

Bedded salt (Louann Salt) was encountered in a well in the Cayuga oil field at a depth of 13,726 feet. It is of no commercial value at this time.

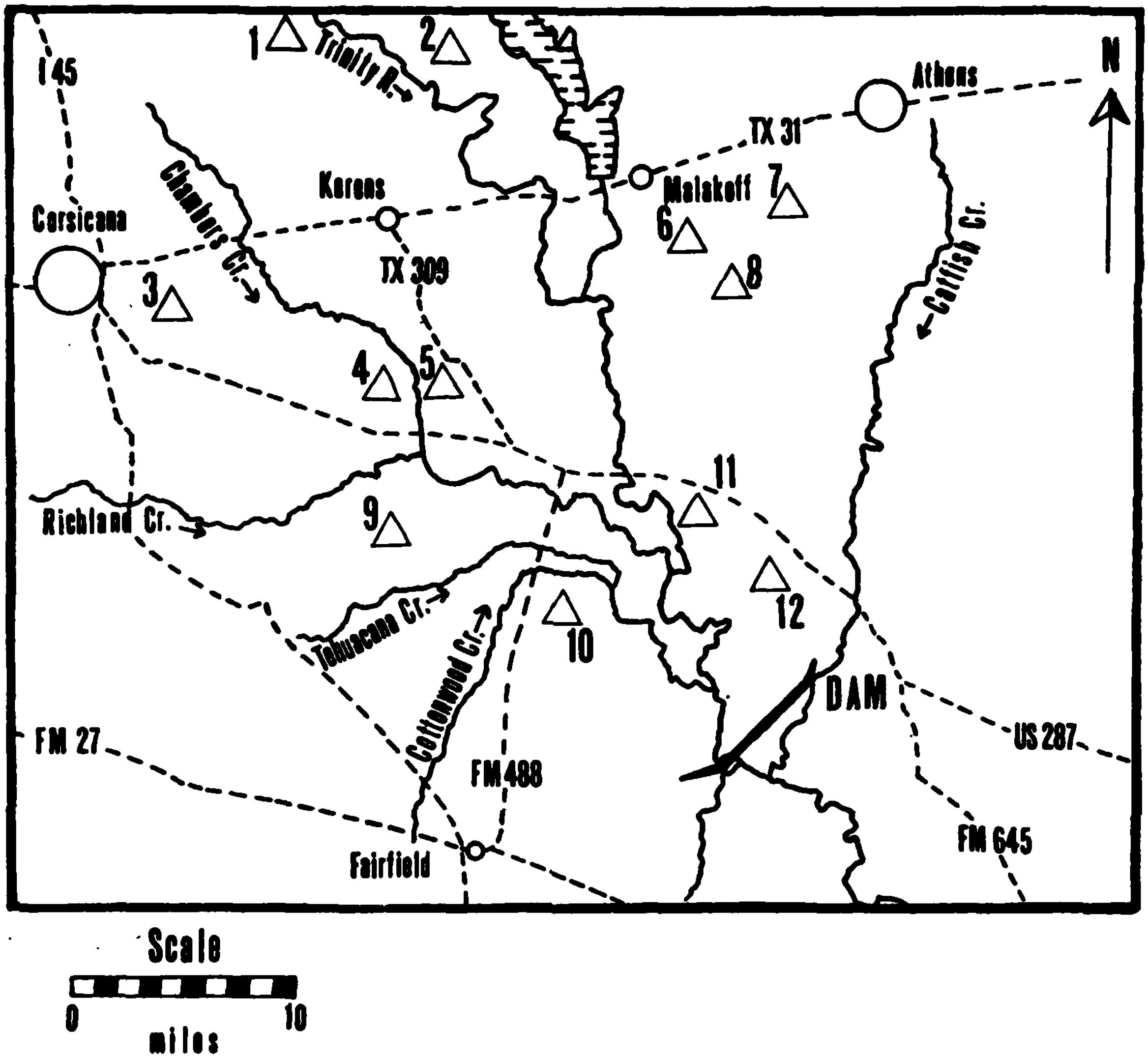

Figure B8: OIL FIELDS

Oil fields in the immediate reservoir area are:

No. 1	Bazette
No. 2	Flag Lake
No. 3	Powell
No. 4	Carter - Cragg
No. 5	South Kerens
No. 6	Stephens Lake
No. 7	South Malakoff
No. 8	Tri - City
No. 9	Reka
No. 10	Stewards Mill, West Stewards Mill
No. 11	Cayuga
No. 12	Bethel, and Bethel salt dome

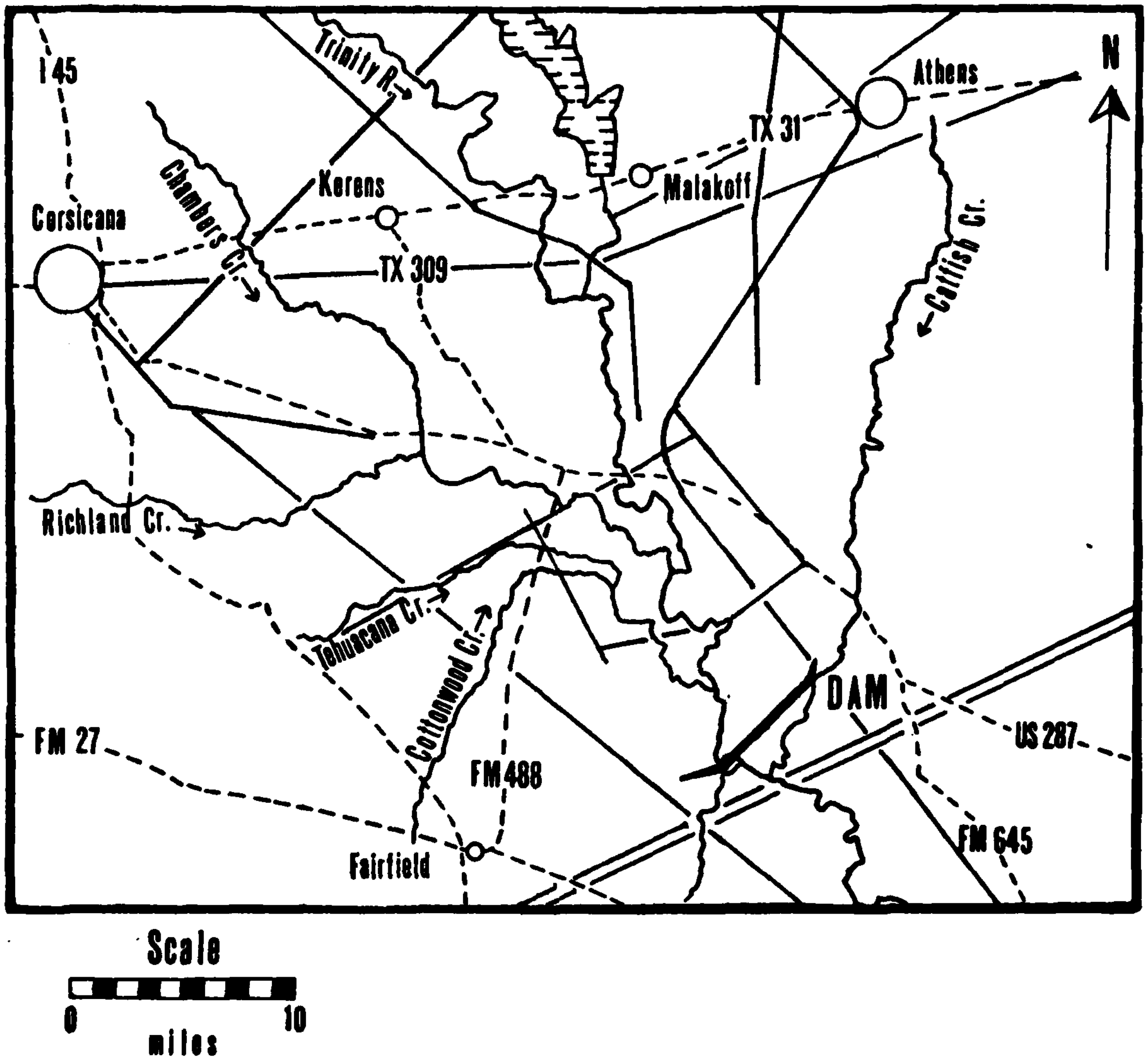

Figure B9: OIL AND GAS PIPELINES

Numerous oil and gas pipelines are located in the area of the future reservoir. Their relocation is necessary.

Table B5: Oil and Gas Fields in the Survey Area.

Name of field	Producing Company	in/or apparently in production	not/or apparently not in production	Geological Hazards	Remarks
Bethel	Texaco Inc.	x in south part of the field, 1957-present.		Sludge pits and pollution noticed. Brines are supposedly pumped into disposal wells.	Salt dome structure trap in 5500-8700 feet depth, new drilling of well
Cayuga	Texaco Inc. & Getty Oil Co.; Getty is operator (Southern part of field). American Petrofina Company of Texas	x		Large extent of present pollution by oil and brines. Many unlined sludge pits.	Reserves for approximately 10 years.
Stephens Lake			/x		
South Malakoff Tri-City					

Table B5. Continued

South Kerens	Texaco Inc. & Edson Co.	x		Present pollution by unlined sludge pits.	
Reka	Colorado Oil & Gas Corporation	x		Sul	
South of Streetman Freestone Co.	Getty Oil Company	x		Sulfur is recovered from the gas.	Smackover Fm., depth 11000' - 13000' feet
W. Stewards Mill		x			
Stewards Mill	Basin Operating Company		/x		
Bazette					
Flag Lake					

GROUNDWATER

Rock bodies are considered to be aquifers if they are capable of producing water. Aquifers occur in the major part of the area (Fig. B10).

The most important aquifers in the area are inter-layered sands, silt, and clay of the Wilcox Group and the Carrizo Formation, collectively referred to as the Carrizo-Wilcox aquifer.

The alluvium in the floodplains covers approximately 90% of the future reservoir area. It exhibits very variable permeability due to the discontinuous extent of the lithological units e. g., gravels, sands, silt, and clay.

At the present time, water in the Carrizo-Wilcox aquifer occurs usually under water table conditions. In a downdip direction, water occurs under artesian conditions because the aquifer is capped by the impermeable, argillaceous Reklaw Formation.

In the area of the reservoir, groundwater currently moves toward the Trinity River. The water-table gradient is estimated to be up to 10 feet per mile.

The Carrizo sand has coefficients of transmissibility of approximately 25,000 gpd/ft with coefficients of permeability in the order of 350 gpd/ft. The Wilcox Formation has very variable coefficients of transmissibility resulting from the variability of the strata. However, due to its considerable thickness a coefficient of transmissibility of 20,000 gpd/ft can be assumed as an average figure with

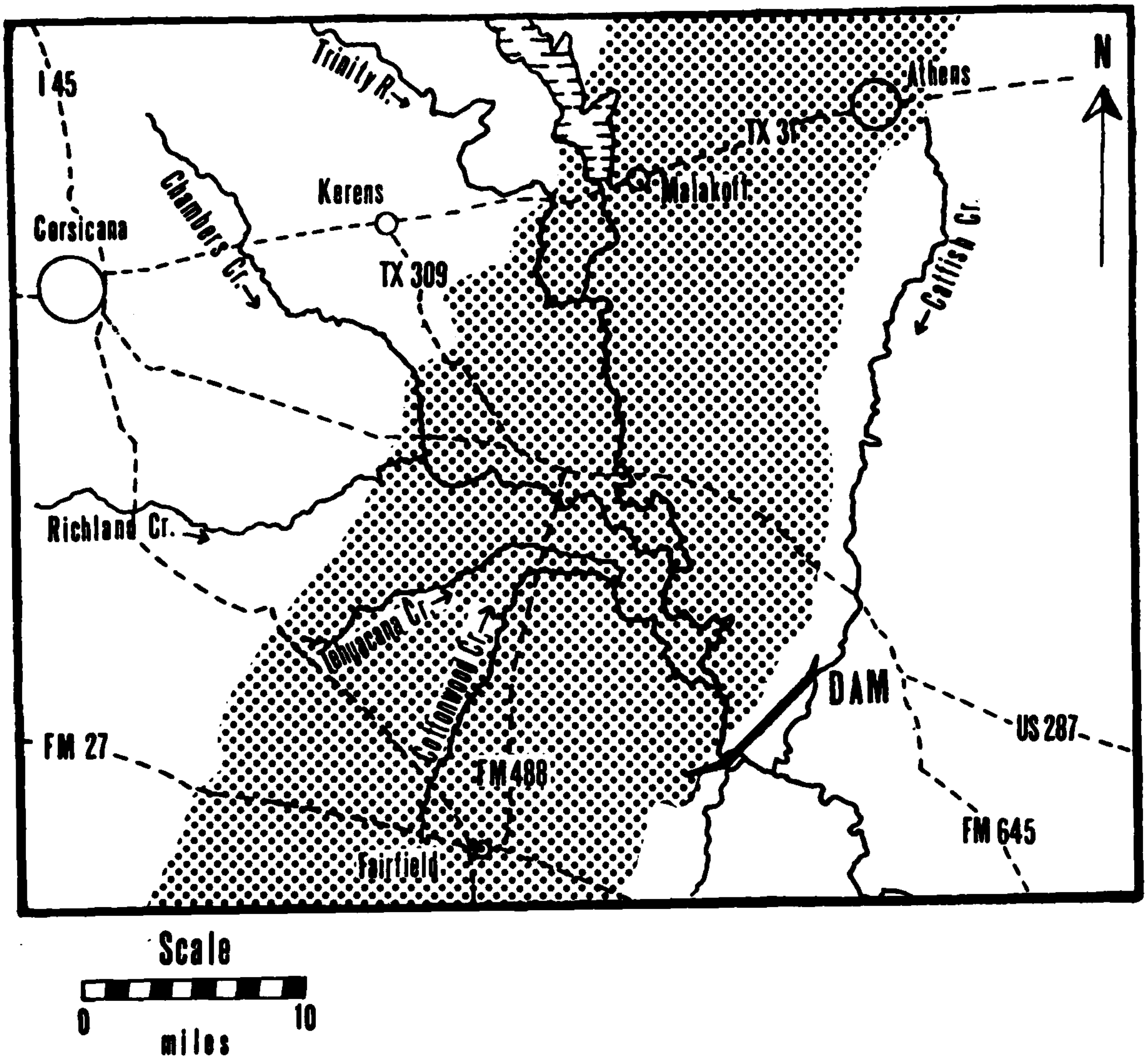

Figure B10: EXTENT OF CARRIZO-WILCOX AQUIFER.

Sandstones of the Wilcox Group and Carrizo Sand constitute the dominant aquifer in the proposed reservoir area. They underlie a major portion of the lake area.

a coefficient of permeability slightly less than 350 gpd/ft (Peckham, et. al., 1963). The coefficients illustrate that groundwater can move very freely through the strata.

The rocks in the remaining part of the area are not capable of producing sufficient quantities of groundwater to feed springs and wells. They are called aquicludes. The waters of the northern part of the reservoir will come into contact with the aquicludes of the Midway Group and possibly the Navarro Group consisting of clays with occasional sand lenses and stringers. Another aquiclude, the Reklaw Formation occurs immediately north of the proposed dam.

Presently, groundwater is supplied almost exclusively from the Carrizo-Wilcox aquifer for municipal, industrial and agricultural uses. A minor source of water is the alluvium in the valleys.

GEOLOGICAL EFFECTS OF FLOODING

Creation of the Tennessee Colony reservoir will result in certain geological changes within and adjacent to the area. Most of the adverse effects are related to industrial activities and can be avoided by taking proper protective measures.

IMMEDIATE EFFECTS

Industrial Operations

The alluvial plains of the Trinity River and its tributaries will be flooded by the reservoir waters. The inundation will affect several industrial operations which have either to be relocated or abandoned.

Pumping stations, storage tanks, sludge pits, and pipelines of many oil and gas fields will be submerged (Fig. B8, 9). Especially affected will be the facilities of the Cayuga, Carter-Cragg, Reka, and Stewards Mill oil fields. Brine and crude oil of the sludge pits and the area around them will enter immediately into the water cycle of the reservoir. Some of the fields are old and no longer at peak production but their continued operation, even on a reduced scale, would benefit the economy of this area. For continued operation, however, their facilities must either be elevated above the future lake level, relocated outside the affected area, or discontinued. If the facilities were elevated, excess channel-cut material could be utilized, however, relocation is considered to be

the most desirable of the alternatives. New techniques of exploration and production must be employed if future exploitation of potential petroleum reserves in the flooded area is pursued.

The flooding of drinking water wells will directly effect the water supply of the city of Trinidad and several industrial operations in the area. This should not pose a severe problem because their water needs could be satisfied from the reservoir if the water quality meets standard requirements.

Sand and gravel production areas in the Trinity River valley including the Julian gravel pit near Turkey Creek, Henderson County, will be submerged. The operation will ultimately have to be abandoned.

The sands and gravels from the pit can be effectively utilized during the construction phase of the project.

Bog areas in the flood plain containing potential peat deposits will be totally submerged. The peat cannot be recovered after the dam construction.

Open pit mining of the clays will not be affected by changes in the level of the ground water table because most of the areas with possible clay deposits are located some distance from the lake. Future mining of the Bethel salt deposits will probably not be affected by groundwater changes.

Geological Localities

With the lake at the anticipated normal water level, some fossil localities along the cliffs east and west of the Trinity River northeast of Kernes, Navarro County, will be inundated (Fig. B1). Most of the localities are not considered to be of great significance. They are sparingly fossiliferous and contain mostly microfossils which might be collected elsewhere. The only possibly significant locality is station No. 3 which is the only outcrop to yield the foraminifera *Cornuspira Carinata*.

In addition, the geologic type locality of the Kerens Member, Wills Point Formation, will be submerged. The location is the cliff west of the Trinity River northeast of Kerens.

LONG-RANGE EFFECTS

Creation of the reservoir will have a number of long-range effects in the area. They result from industrial activities or are effects which are related to natural geological processes.

Oil-field Pollution

Oil is produced in a number of oil fields, and brine is pumped with the oil. Ionic constituents of oil-field brines are essentially sodium, chloride, and frequently sulfate. Poor oil-field brine-disposal practices have resulted in drainage of these brines into the tributaries and into the Trinity River. Available data of Osborne and Shamburger (1960) show the extent of the pollution. They conducted a study of the effects of oil-field brine on water quality in the lower watershed of Chambers and Richland Creek, Freestone County, and reportea a total daily brine yield of 95,300 barrels. Of this amount, approximately 83,700 barrels per day were disposed of on the surface. Their conclusion was that approximately 61.500 barrels drained daily directly into the tributaries of Chambers and Richland Creek.

The brine increases the salinity of the tributaries and the reservoir water. Leifeste and Hughes (1967) found chloride concentrations in Richland Creek to be usually greater than 1,000 ppm and at times exceeding even 7,000 ppm. They also reported the pollution of Tehucana Creek

waters by discharged oil-field brines.

Presently documented information appears not to be available about the amount of oil-field brines produced by the other fields in the project area nor information about their techniques of oil-field brine disposal. It is known, however, that brine is produced in nearly all fields in the Trinity River basin and that the brine is frequently pumped into unlined sludge pits or directly discharged into surface water drainage (Leifests and Hughes, 1967). Usage of disposal wells appears to be an uncommon practice.

Density Stratification

The discharge of brine-polluted creek waters into the reservoir with its restricted circulation may result in density stratification in the reservoir basin. The denser creek waters tend to underflow the less dense lake water and to displace it upwards. The lack of circulation within the lower levels of the lake water soon results in reducing conditions near the bottom of the basin. The activity of anaerobic bacteria on bottom matter would soon produce large quantities of ammonia and possibly hydrogen sulfide gas, both seriously affecting the water quality, plant and animal life. Flushing of the reservoir is a measure to correct this situation but would produce harmful and lethal conditions downstream, e. g. large fish-kills (Eley, R. L. et. al., 1967).

Siltation

The higher salt content of the water will increase the rate of siltation because the presence of larger quantities of salt in water causes the flocculation of the suspended clay particles and ultimately, their sedimentation.

This accelerated siltation contributes to the normal silting in the reservoir basin.

The upper Trinity River drainage basin and the local tributaries will discharge a large suspended load into the reservoir. Causes are natural soil conditions, climatic and seasonal fluctuations of the precipitation, and land management practices. The average suspended load input varies on a monthly and annual basis, and appears to fluctuate with the seasonal rainfall. The highest input occurs usually during the spring which is the rainy season and the time of most active cultivation of the land.

Data from the Rosser water sampling station (located at State Highway 34 bridge between Ennis and Rosser, approximately 45 miles upstream from the proposed dam site) reveal that over the six year period from 1954 to 1959 an average of 1,265,819 tons per year of suspended load passed the station. The net drainage area above this station covers 8,162 square miles. Data from the Romayer station (located at State Highway 105 bridge, 2 miles south of Romayer, approximately 112 miles downstream from the proposed reservoir) show that an average of 3,377,765 tons per year passed

that point between 1954 and 1959 (Stout, I. M. et. al., 1961). The net drainage area for this station covers 17,192 square miles. This resulted in an input of approximately 2,112,000 tons per year of suspended load between the two sampling stations. It is estimated that approximately 1,003,200 tons per year or 47.5% were contributed by the drainage area between the upstream station and the Tennessee Colony dam site. The estimated suspended load input into the reservoir for the years 1954-1959 amount to approximately 2,269,019 tons per year.

Channel realignment and widening causes changes in the water flow regime, i. e., increase of flow velocity, turbidity. Erosion of the unconsolidated flood plain deposits and transport capabilities are enhanced. The rate of silting-up is increased when the river and creek currents are slowed down upon entry into the still water of the reservoir. Therefore, the higher rate of silting-up will occur in the shallow parts of the reservoir.

Pollution by Lignite Utilization

Lignite strip-mining and processing in the vicinity of Fairfield may create problems for the Tennessee Colony reservoir.

Apparently, facilities to remove sulfur dioxide and possible mercury vapor from the stack emissions were not installed in the Big Brown Steam Electric Station. The gases will directly be released into the atmosphere. Reaction of sulfur dioxide with atmospheric moisture results in the formation of sulfuric acid. Prevailing southwest to northeast winds widely disperse the gas, the acid, and the vapor (?) in a downwind direction.

The acid and the mercury (?) have immediate harmful effects on the vegetation in the adjacent area. Concentration may occur in the drainage basin and in the reservoir itself. Even slight traces of mercury in water are considered a health hazard since mercury retention in the body is a cumulative process, and above a certain concentration it tends to destroy the nerve cells in the central nervous system (Kurland, Faro, and Siedler, 1960).

An increase in the acidity of the surface waters around the mine is also possible and is caused by the oxidation of iron sulfides in the lignite and the natural production of sulfuric acid.

Pollution by Gas Torching

The torching of undesirable gas which is usually done at the well site appears to have been or to be a common practice. If the gas contains appreciable amounts of sulfur the burning increases substantially the sulfur dioxide content of the atmosphere.

Groundwater changes

Presently, the water table slopes towards the alluvium of the drainage basin. The initial effect of an impoundment on the groundwater will be the reversal of the slope of the water table adjacent to the reservoir. The only noticable effects will be the water level increase in wells and a more uniform water level in stock ponds under water table conditions.

Impoundment may also produce recharge to the aquifers by lake water. The alluvium in the reservoir will control the rate of recharge of the aquifers assuming that the aquifers have a higher permeability than the alluvium.

The water in the aquifers is under artesian condition in a downdip direction. Natural discharge of artesian water occurs by leakage through the confining beds of the Reklaw Formation and Queen City Sand.

Artificial discharge occurs by pumping and flowing wells. The only important or large artesian well field is near Palestine in Anderson County. At the present time, a small cone of depression has developed in the well field. The rate of decline of the water level in the aquifer near

the well field has been relatively small. Natural recharge has been able to keep pace with the natural and artificial discharge. Artificial recharge from the reservoir to the aquifer should increase the availibility of water for municipal and industrial use. Only seasonal fluctuation of the amount of water contained, occurs outside of the Palestine well field.

Silting of the bottom of the reservoir could reduce the effectiveness of the artificial recharge. Silting would reduce the effective permeability in the area of recharge, and consequently reduce the amount of water moving from the reservoir into the aquifer.

In the area of Catfish Creek east of the reservoir, seepage and ponding due to a raised groundwater table is likely to present a problem. Catfish Creek is developed on the Queen City Sand and the Reklaw Formation, and empties into the Trinity River below the proposed dam. The Reklaw Formation is classified as an aquiclude, however, in the upper part of the stratigraphic section occur thin sand layers which yield small amounts of water.

The flood plain of Catfish Creek is at a lower elevation than the projected water level in the reservoir. At the present time, the water table slopes towards the Trinity River and Catfish Creek as well. With an increased elevation of the water table, the slope would be from the reservoir toward Catfish Creek favoring the seepage and

water flow from the lake towards the creek area. Whether or not his situation will cause swamp and marsh conditions in the valley of Catfish Creek will depend upon the porosity and permeability of the Reklaw Formation which may act as an impermeable layer. These characteristics have to be known before a definite conclusion can be drawn.

A possibility of waterlogging of the soil and the development of a swampy condition exists for the area of the town of Trinidad. After construction of the reservoir, Trinidad will lie on a narrow peninsula between Cedar Creek and the Trinity River. The water table should slope up from the reservoir on both sides of the penisula, with a reversal of the water-table slope under the city. The amount of slope of the water table will depend on the porosity and permeability of the soil and bedrock along the peninsula. These factors are not known at the present time. If the porosity and permeability of the underlying materials are low, there will be no ponding but if they are high or moderate a definite possibility of swamp development will exist.

Excessive seepage of the lake water into the fault zones in the northern part of the reservoir is not anticipated. It has also, to our best knowledge, not been reported from Cedar Creek reservoir which is also intersected by these graben faults.

CONCLUSIONS

Creation of the Tennessee Colony reservoir will have a number of immediate and long-term geological effects in the area. The following conclusions were drawn:

IMMEDIATE EFFECTS

Inundation of portions of existing field production and disposal facilities of several oil fields will result in loss of existing and potential income. If the affected fields are to continue to operate, oil-pumping and storage stations and oil and gas pipelines must be either elevated above the future lake level, relocated out of the lake area or be abandoned. Elevation of well sites constitutes a sight pollution and a hazard to navigation. The danger of leakage and accidental brine and oil pollution remains high. Perhaps some of the undesirable channel excavation materials could be used for the elevation of the well sites if this technique is desirable. Relocation of the facilities appears to be the best solution.

Different disposal techniques of the oil-field brines must be practiced by the producing companies. The optimum alternative would be to pump the refuse into old, depleted disposal wells.

Future drilling in the reservoir area would render more difficult and would be undesirable.

The water well furnishing the water supply for the city of Trinidad and the wells for several industrial

operations will be submerged. The problem can be overcome by satisfying the water requirements from the reservoir.

Flooding of sand and gravel production areas will result in the loss of a valuable source of construction materials and income for the area as well. Sand and gravel should be effectively utilized for the many construction activities of the project, e. g., locks and dams, roads, park, and recreational facilities. Potential clay deposits in the area will probably not be adversely affected by the proposed reservoir. Rather, lower shipping costs resulting in lower overall production costs will possibly encourage greater development of these deposits.

It is felt that flooding of the type locality of the Kerens member of the Wills Point Formation east of Kerens, Navarro County, will not be an important loss. The locality has been adequately described, and a new, satisfactory alternate could probably be located.

Several fossil localities along the cliffs of the Trinity River northeast of Kerens will be flooded. These localities are not considered to be significant because they are sparingly fossiliferous and contain mostly microfossils which may be located elsewhere. A possibly significant locality is location No. 3 which is the only outcrop to yield the foraminifera _Cornuspira Carinata_.

LONG-RANGE EFFECTS

Several potential geologic hazards are associated with the creation of the reservoir, but it is felt that these can be overcome if a sincere effort is made to do so under the strong guidance of the appropriate state and federal agencies. The inundation effects include:

Potential pollution by oil field brines and oil which are commonly retained by present practice in unlined pools or are discharged onto the ground and into creeks. The contamination of the lake water by brines results in a considerable increase in the water salinity. Potential oil and oil-field brine pollution can be avoided through careful production, storage, transport and disposal practices in compliance with state and federal regulations. The practice of pumping waste disposal into deep disposal wells must definitely be the rule adhered to. Provisions should be made for frequent monitoring of creeks draining the oil fields to insure that this practice is carried out.

Density stratification in the lake water is possible, the denser saline water forming the lower water layer in the basin which causes anaerobic, toxic conditions.

Salinity also causes an increase in flocculation and sedimentation of clay minerals.

The overall result is a decrease in water quality which makes water purification for drinking water production more costly, and a rapid rate of silting-up of the

reservoir. Flushing of the basin to remedy this situation would produce many adverse affects downstream including large fish kills.

The discharge of sediments by the tributaries into the shallow-water subbasins will cause their progressive silting-up which is also promoted by the possible increased salinity and clay flocculation of the lake water. Water quality is in either way decreased. The biological aspects of this precess will be considerable.

The strip-mining of lignite north of Fairfield County for fuel to generate electric power by the new Big Brown Steam Electric Station northeast of Fairfield poses a possible pollution problem. These lignites contain sulfur and possibly mercury compounds. Apparently, sulfur dioxide gas will not be removed from the stack emissions which would also apply to possible mercury vapor. This results in a considerable sulfur dioxide and mercury concentration in the emissions. Dispersal by winds has adverse effects in the downwind areas including pasture land, the reservoir, and its drainage area. An increase in the acidity of surface waters in the neighborhood of the strip-mined area is possible.

Frequent monitoring of the air and soil in a downwind direction should be conducted to insure that acid and mercury pollution are at a minimum. This applies also to surface water drainage from the area of the lignite mining to

insure that acid pollution of local drainage networks is fully controlled.

The potential hazards involved in burning of lignite can be overcome by the installation of adequate removal equipment in the emission system of the plant. It may, however, require considerable research to come up with an effective and economic filtering system.

Much of the gas produced is high in sulfur content and the practice of burning undesirable amounts of gas increases the sulfur dioxide content of the atmosphere. This pollution can be avoided by elimination of such disposal techniques.

Disposal of large amounts of channel-cut material in excess of that required for construction fill may be accomplished by reclamation of excessively shallow lake water areas by building them up. The areas could be converted to park and recreational facilities. Other uses could include fill for roads and highways, rehabilitation of blighted areas caused by gravel and clay pits, and fill for possible elevation of oil field facilities in the project area.

Aquifers occur in the major part of the area and will be inundated by the lake. The Carrizo-Wilcox aquifer is the primary supplier of groundwater for municipal, industrial and agricultural uses. A minor source of water is the alluvium in the valleys.

The initial effect of the impoundment on the ground-

water will be an increase in the water level in the wells and a more uniform level in stock ponds under water table conditions. Recharge to the aquifers from the reservoir may take place. This would increase the availability of groundwater for municipal and industrial use. Recharge of the aquifers will accelerate the artificial discharge by artesian wells in a downdip direction. However, the silting of the bottom of the reservoir could reduce the effectiveness of the artificial recharge.

Seepage and ponding in the area of Catfish Creek east of the reservoir may present a problem. Whether or not these processes will occur depends upon the porosity and permeability of the Reklaw Formation. Its rock mechanical characteristics must be determined before definite conclusions can be drawn.

The possibility of the formation of swampy conditions exists in the Trinidad area and under the city itself and must be considered.

Potential peat deposit areas in the flood plain of the Trinity River will be inundated by the reservoir. Peat could effectively be utilized as soil conditioner to help build-up the soil in parks and other recreational areas; however, whether a peat recovery would be feasible or not remains open.

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APPENDIX C

BOTANICAL ELEMENTS

TENNESSEE COLONY RESERVOIR

by

Elray S. Nixon

with the
assistance of

Michael McCrary
and
Charles L. Burandt

TABLE OF CONTENTS

	Page
LIST OF TABLES	iii
LIST OF FIGURES	v
INTRODUCTION	C - 1
METHODS AND PROCEDURES	C - 4
RESULTS AND DISCUSSION	C - 6
Creek Areas (East Side of Trinity River)	C - 6
Engeling Wildlife Management Area	C - 6
Keechie, Catfish and Beaver Creeks	C - 16
Mitchell, Indian, Wildcat, Turkey, Walnut and Cedar Creeks	C - 25
Creek Areas (West Side of Trinity River)	C - 27
Indian, Rush and Alligator Creeks	C - 27
Chambers and Richland Creeks	C - 37
Tehuacana, Cottonwood, Prairie and Big Brown Creeks	C - 39
Comparison of Woody Species of East-and West-Side Creeks	C - 40
River Basin	C - 42
Significance of the Woody Vegetation	C - 58
Significance of the Herbaceous Vegetation	C - 60
Rare and Endangered Species	C - 62

TABLE OF CONTENTS (CONTINUED)

Page

Environmental Impact of the Tennessee Colony Reservoir on Vascular Plants................C - 89

Woody Vegetation..........................C - 90

Herbaceous Vegetation.....................C - 97

Zonation..................................C - 99

Downstream Effects........................C - 101

CONCLUSIONS.......................................C - 102

RECOMMENDATIONS...................................C - 105

LITERATURE CITED..................................C - 106

LIST OF TABLES

		Page
1.	Estimated abundance of shrub and tree species in the vicinity of Catfish Creek within the Engeling Wildlife Management Area	C - 8
2.	Estimated abundance of shrub and tree species associated with creek areas on the east side of the Trinity River	C - 17
3.	Estimated abundance of shrub and tree species associated with creek areas on the west side of the Trinity River	C - 28
4.	Estimated abundance of shrub and tree species in the Trinity River basin area between Highway 85 and Highway 31	C - 44
5.	Estimated abundance of shrub and tree species in the Trinity River basin area between Highway 31 and Highway 287	C - 47
6.	Estimated abundance of shrub and tree species in the Trinity River basin area between Highway 287 and Highway 84	C - 52
7.	Checklist of rare and endangered plants in east Texas forests and Blackland Prairie	C - 63
8.	Checklist of shrub and tree species within the proposed Tennessee Colony Reservoir area	C - 65

LIST OF TABLES (CONTINUED)

Page

9. Checklist of herbaceous and vine species within the proposed Tennessee Colony Reservoir area......C - 70

LIST OF FIGURES

Page

1. Map positioning the proposed Tennessee Colony Reservoir in relation to surrounding vegetational areas (After Gould, 1969)............... C - 2
2. Map of the proposed Tennessee Colony Lake showing study sites (Numbers 1 through 28) along the Trinity River and creek areas which were investigated.................................. C - 7

INTRODUCTION

From its beginning northwest of Fort Worth, Texas in Archer County, the Trinity River extends some 350 miles (692 river miles) to Trinity Bay near Anahuac, Texas (U. S. Study Commission, 1962). The total fall in elevation for the river is approximately 1,250 feet. The Fort Worth District of the Corps of Engineers in cooperation with the Trinity River Authority has proposed the construction of a reservoir near Palestine, Texas which will be called Tennessee Colony Lake. This reservoir, located on the Trinity River, will occupy about 147,000 acres of land. The object of this study was to conduct an environmental inventory of the botanical elements related to the area in and around Tennessee Colony Lake by examining such factors as virgin or important forests, champion trees and unique ecological areas. The project was initiated September 1, 1971 and terminated January 31, 1972. Field work was terminated November 5, 1971.

Geographically the Tennessee Colony Lake area is within Navarro, Henderson, Freestone and Anderson Counties. The topography is flat to gently rolling and hilly. Vegetationally it is placed in the Post Oak Savannah and Blackland Prairie vegetational areas of Texas (Gould, 1969). The Pineywoods vegetational area approaches Tennessee Colony Lake in the southwestern part of Anderson County (Fig. 1).

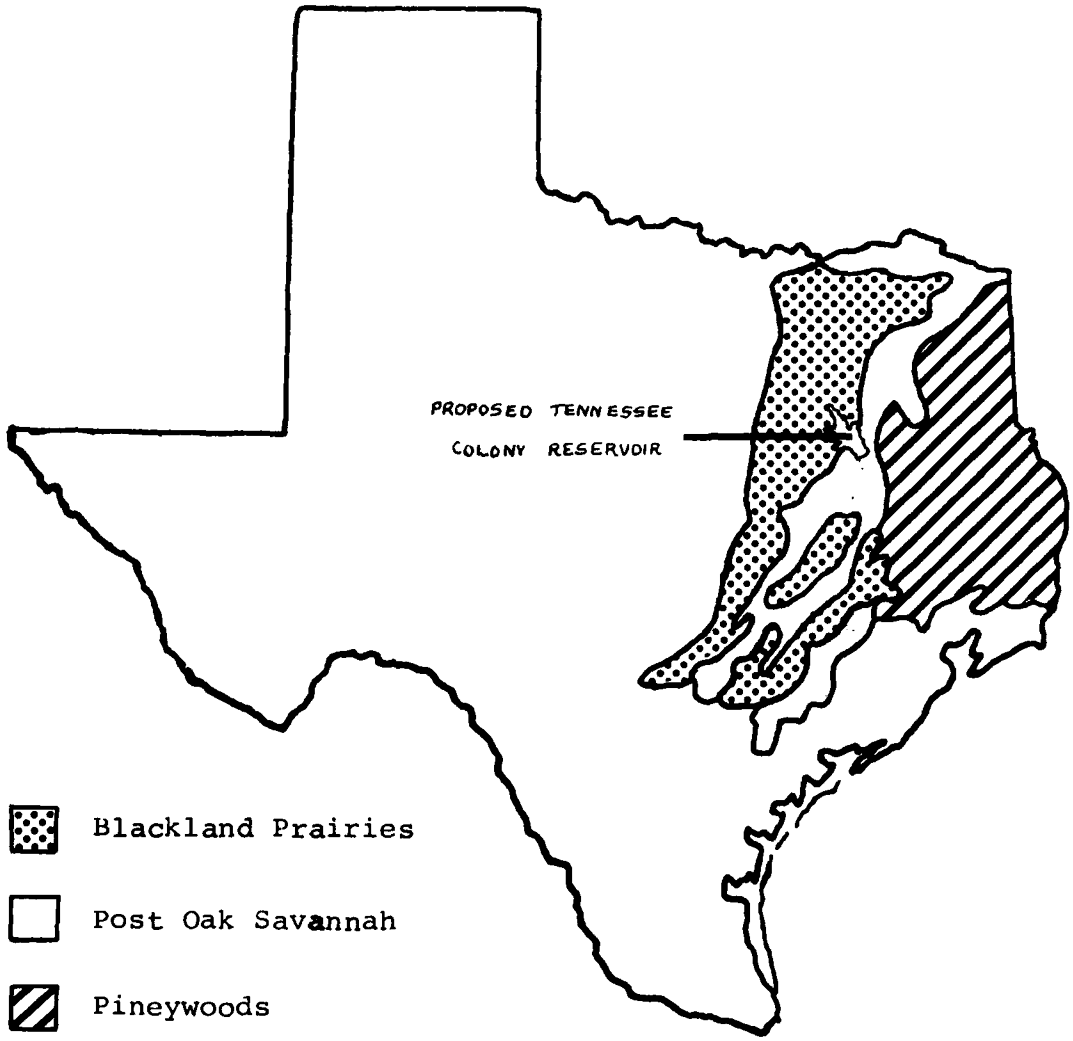

Fig. 1. Map positioning the proposed Tennessee Colony Reservoir in relation to surrounding vegetational areas. (After Gould, 1969).

In general, the Post Oak Savannah is characterized by the presence of upland trees such as post oak (Quercus stellata), blackjack oak (Quercus marilandica) and sandjack oak (Quercus incana) and of marginal bottomland species including southern red oak (Quercus falcata), white oak (Quercus alba), hickory (Carya spp.) and elm (Ulmus spp.) (Bray, 1906). McBryde (1933) listed black hickory (Carya texana), post oak and blackjack oak as dominants on the Carrizo, Wilcox, and Mount Selman soil formations which transect Henderson, Anderson and Freestone Counties. The upland soils of the Post Oak Savannah area are light colored, generally acid and are texturally classed as either sands or sandy loams. Bottomland soils are darker in color, acid, and range from sandy loams to clays (Gould, 1969).

The Blackland Prairie, under natural conditions, would be dominated by grasses such as little bluestem (Schizachyrium scoparium), big bluestem (Andropogon gerardi), switch grass (Panicum virgatum), Indiangrass (Sorghastrum avenaceum) and sideoats grama (Bouteloua curtipendula). The soils are generally dark-colored calcareous clays (Gould, 1969).

The Pineywoods Vegetational area is depicted by trees such as shortleaf pine (Pinus echinata), loblolly pine (Pinus taeda), post oak, blackjack oak, red oak, sweetgum (Liquidambar styraciflua) and black hickory in uplands and by overcup oak (Quercus lyrata), willow oak (Quercus phellos),

Texas sugarberry (Celtis laevigata), cedar elm (Ulmus crassifolia) and bush palmetto (Sabal minor) in bottomlands (Tharp, 1929, 1939, 1952,; Braun, 1950). The soils are usually light colored, acid and sands or sandy loams (Gould, 1969).

Although the Tennessee Colony Lake area is associated with the Post Oak Savannah, Blackland Prairie and Pineywoods vegetational areas, the vegetation type of great concern in this study was that of hardwood bottomland forests. Bottomland forests associated with the Sabine, Neches, Trinity, and San Jacinto River systems occupy large areas and, as a result, have been classified by Bray (1906) and Collier (1964) as distinct vegetational types. These bottomland forests are considered to be westward extensions of hardwood forests typical of river bottom areas to the southeast (Bray, 1906; Braun, 1950).

METHODS AND PROCEDURES

An inventory of the kinds of vascular plant species present in and around the Tennessee Colony Lake area was made for both woody and herbaceous plants. Voucher specimens were collected for each individual species and were placed in the Stephen F. Autsin State Universtiy Herbarium. In order to better understand the relative importance of species, an estimate was made of the abundance of each shrub

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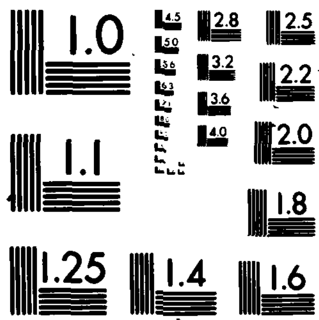

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and tree species. The scale of estimate used was as follows:

D - Dominant
A - Abundant
F - Frequent
O - Occasional
R - Rare

Dominance, therefore, when used in this study, is based upon estimated abundance. Abundance estimates were not listed for vine and herbaceous species except where deemed important. Checklists were prepared for herbaceous and vine species and for shrub and tree species. Nomenclature followed that of Correll and Johnston (1970).

As a result of the short time period (September to November) for collecting and recording plants, only representative areas were studied. The areas were selected on the basis of location and disturbance. Each site was studied by walking over as much of the area as possible. The magnitude of the proposed Tennessee Colony Lake dictated that each site be visited once. As a result of studying representative areas and of single visits to each study site, it is possible that some species present in the Tennessee Colony Lake area at the time of this study, were not collected.

Although present in the proposed Tennessee Colony Lake area, species of non-vascular plants from groups such as the fungi, lichens, mosses, and liverworts, were not included. Dr. Jack D. McCullough has presented information concerning algae, coliform bacteria and some hydrophytic vascular plants in his section of this report on eutrophication and pesticides.

RESULTS AND DISCUSSION

Creek Areas (East Side of Trinity River)

Creeks on the east side of the Trinity River which might be partially or wholly inundated by the proposed Tennessee Colony Lake were examined beginning with Keechie Creek to the south and ending with Cedar Creek to the north (Fig. 2) (Tables 1 and 2). Inundation of these creeks would generally occur from about 3 to 8 miles (not creek miles) extending from the present course of the Trinity River. Tables 8 and 9, which are checklists of the woody and herbaceous species found in the Tennessee Colony Lake study area, include species from these creek areas and can be referred to for scientific and common names of species.

Engeling Wildlife Management Area

The Engeling Wildlife Management Area contains 11,941 acres. Its pronounced ecological diversity ranges from dry upland rolling areas to flat bottomlands in association with Catfish Creek. Small creeks and springs originating in more upland sites flow into Catfish Creek. In addition, fairly extensive marsh and swamp areas exist. There are approximately 2,500 acres of bottomland area and 200 acres of marsh and swamp area.

The dryer upland areas with their sandy to sandy loam soils were characterized by the presence of trees and shrubs

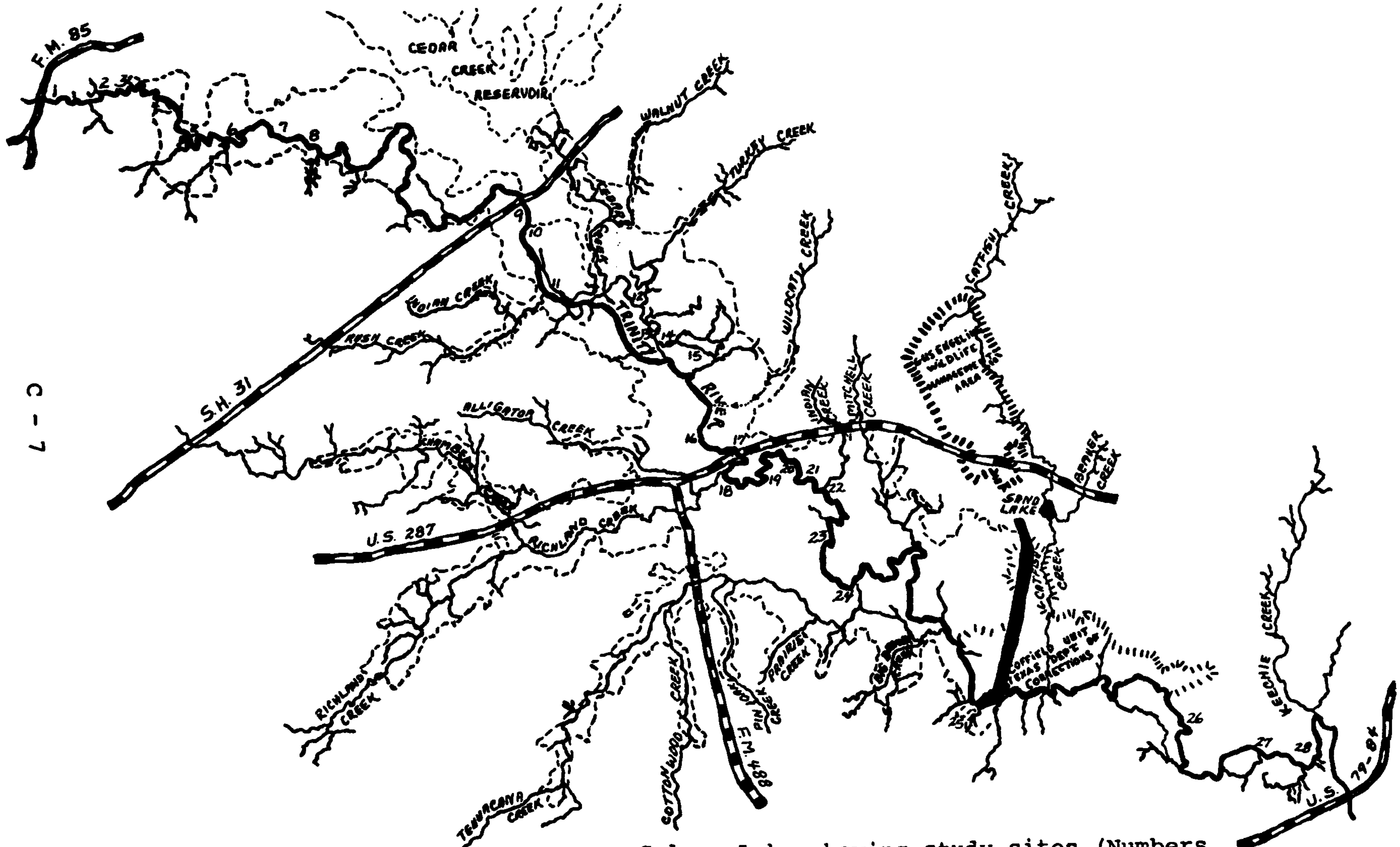

Fig. 2. Map of the proposed Tennessee Colony Lake showing study sites (Numbers 1 through 28) along the Trinity River and creek areas which were investigated.

Table 1. Estimated abundance* of shrub and tree species in the vicinity of Catfish Creek within the Engeling Wildlife Management Area.

Species	Upland	Transition (bottom-land to upland)	Kidd Spring Area	Long Branch Creek	Transition (bottom-land to upland)	Catfish Creek (upper end)	Catfish Creek (upper middle)	Catfish Creek (lower middle)	Catfish Creek (lower end)
	Areas studied								
Acer rubrum		O-F	A-D	F-A			A	O	O
Alnus serrulata			O-LA	R-O					
Betula nigra		O	O	A		A	F	F	F-A
Callicarpa americana			LA	A	O-F				
Carpinus caroliniana		R-O	R	F				F-A	F-A
Carya aquatica				O		F	F	O	O-F

Table 1. Continued

Carya texana	F	O	R		O-F		R		
Carya tomentosa	O				R				
Celtis laevigata				R					
Cephalanthus occidentalis		O	R-O			LO	O		
Cornus florida	LF	O-F	O	O-F	O		R-O		
Crataegus spp.		O		R					
Diospyros virginiana				R		R			R-O
Forestiera ligustrina					R				
Fraxinus pensylvanica				R-O					
Ilex decidua					R	O			
Ilex opaca	R	R-O	R-O		R		R	O-LF	R
Ilex vomitoria		O-F	R	O	F			O	R
Juniperus virginiana		R-LO	R	R	O				
Liquidambar Styraciflua	R	F	O-F	A		R		O-F	R-O
Morus rubra		O	R	O-F	O	R			
Myrica cerifera		F	F	O-F			A	O	R

Table 1. Continued

Nyssa sylvatica		F-A	A	F-A		R		F	O
Planera aquatica		R				O-LA	D	O	F-A
Prunus mexicana					O				
Quercus falcata		R	O	R-O	O		O-F	R	A
Quercus incana	F-A								
Quercus lyrata				R					F-A
Quercus nigra		O	O-F	F	O	O-F	F	F	F-A
Quercus phellos		R	O	F			O-F	R	O
Quercus Shumardii						O			
Quercus stellata	F	O		R	F		R	R	
Rhamnus caroliniana					O				
Rhus copallina			R						
Rhus toxicodendron	F-A	F						O	
Salix nigra		LF				R-O	O-F	R	R
Sassafras albidum	O				O				
Tilia americana							O		

Table 1. Continued

<u>Ulmus</u> <u>alata</u>		R	R-O	O-F	O		R	
<u>Ulmus</u> <u>americana</u>		R		O-F	R-O	O		
<u>Vaccinium</u> <u>arboreum</u>	F		R	O-F	O			R
<u>Viburnum</u> <u>nudum</u>			O				O	
<u>Viburnum</u> <u>rufidulum</u>	O				R			

*Abundance is based upon the following scale:

D - Dominant

A - Abundant

F - Frequent

O - Occasional

R - Rare

The letter "L" in front of any of the letters above indicates local abundance.

such as black hickory, post oak, farkleberry (Vaccinium arboreum) and sand jack oak (Table 1). Other trees, including blackjack oak, mockernut hickory (Carya tomentosa), flowering dogwood (Cornus florida), and sassafras (Sassafras albidum) occurred occasionally among the more dominant trees (Veteto, 1962). The shrub poison ivy (Rhus toxicodendron) was frequent to abundant in some areas. Prevalent herbaceous species at the time of our visit were wooly croton (Croton capitatus), Palafoxia (Palafoxia Reverchonii), and the endemic clammy-weed, Polanisia erosa. Another endemic, green-thread (Thelesperma flavodiscum) was also flowering at that time.

Interesting vegetational areas existed along the creeks and springs which fed into Catfish Creek. Dominant tree species along Long Branch and Kidd Springs included sweetgum, river birch (Betula nigra), red maple (Acer rubrum), blue beech (Carpinus caroliniana), blackgum (Nyssa sylvatica), and water oak (Quercus nigra) (Table 1). No large trees occurred in these areas. The more prevalent shrubs were wax-myrtle (Myrica cerifera), possum-haw (Viburnum nudum), smooth alder (Alnus serrulata) and American beautyberry (Callicarpa americana). Common green-brier (Smilax rotundifolia) and catbrier (Smilax Bona-nox) were locally frequent vines. Because of a rather dense canopy, the herbaceous layer consisted mostly of sedges. Carex intumescens and Carex joori were abundant in places. The chain fern (Lorinseria areolata) was

locally abundant whereas the royal fern (*Osmunda regalis*) was less prevalent. Some patches of spahgnum moss were present.

The woody vegetation of Long Branch and Kidd Springs correlates very closely with spring and creekside vegetation in Nacogdoches County (Sullivan and Nixon, 1971; Raines, 1971; Chambless, 1971) and in other areas of east Texas (Tharp, 1939). All of the woody species listed in the Long Branch and Kidd Springs areas (Table 1) were listed in creekside studies by Raines (1971). Dominant plants along creeks in Nacogdoches County, as found by Raines (1971), were blue beech, sweetgum, water oak, eastern hophornbeam (*Ostrya virginiana*), white oak, and blackgum. With the exception of eastern hophornbeam and white oak, these correlate very closely with the more prevalent species along Long Branch and Kidd Springs.

Marshes (wet areas without trees) and swamps (wet areas with trees) generally exhibited a different flora. Swamps were dominated by trees such as water elm (*Planera aquatica*) and black willow (*Salix nigra*) and shrubs including common buttonbush (*Cephalanthus occidentalis*) and possum-haw. The fall aspect of herbaceous species included panic grass (*Panicum rigidulum*), joint-tail grass (*Manisuris rugosa*), sugarcan plumegrass (*Erianthus giganteus*), catchfly grass (*Leersia lenticularis*), mist-flower (*Eupatorium coelestinum*), thoroughwort (*Eupatorium perfoliatum*), bulrush (*Scirpus cyper-*

inus) and Persicaria (Persicaria hydropiperoides and Persicaria punctata). Two rare species, narrow plumegrass (Erianthus strictus) and big-rush (Juncus trigonocarpus) were present. Veteto (1962) listed pitcher plants, sundews, bladderworts, orchids and wild irises as being present in these marsh areas. Kral (1955) listed 67 species of plants in a bog area 15 miles south-southeast of Fairfield, Texas. Although this bog is not within the confines of Tennessee Colony Lake, it could give indication of the kinds of plants present in bogs of surrounding areas.

The soils in the bottomland at Catfish Creek are fine sandy loams or silty clay loams. They appear to contain sediments from the Blackland Prairie soils as well as from the more local sandy soils (Veteto, 1962). Dominant woody species in the bottomland area were river birch, water hickory (Carya aquatica), water elm in local populations, and water oak. Towards the lower end of Catfish Creek within the Engeling Wildlife Management Area southern red oak, overcup oak, and blue beech became prevalent. Shrubs were only rare to occasional under the more dense canopy of the bottomland overstory species. Common greenbrier, cat-brier and red-berried moonseed (Cocculus carolinus) were occasional to frequent vines.

There were several large trees in the bottomland area.

One water hickory measured 96 inches in circumference which is 10 inches less than the circumference of the state champion tree (Texas Forest Service, 1971). Several large water elm trees were present. One tree had an estimated index* of 148 but forked at the point of the circumference measurement and may not qualify as a result. The index for the state champion tree of this species is 131. Two other water elms had indexes of 120 and 113 respectively.

Woody vegetation along Catfish Creek appeared to be a combination of creek-side and bottomland species. River birch was a more upland creekside species in a study by Raines (1971). Sweetgum, blue beech, water oak and blackgum were common along upland creeks in Nacogdoches County (Raines, 1971) and were also prevalent on more elevated sites in bottomlands (Chambless, 1971). Kral (1955) in a study near Fairfield, Texas indicated that smooth alder, sweetgum, blackgum, water oak, southern red oak, and American elm were frequently encountered in a bottomland forest in that area.

Herbaceous species were generally restricted to the more open areas in the Catfish Creek bottomland. Chain fern,

*Tree index numbers are based on the following: one point for each inch in stem circumference at 4 1/2 feet above ground level, one point for each foot in vertical height and one point for each foot of average crown spread divided by 4.

false-nettle (*Boehmeria cylindrica*) and Persicaria were locally frequent whereas Chasmanthium (*Chasmanthium laxum*) was more general in its distribution. Panic grasses such as *Panicum rigidulum* and *Panicum gymnocarpon* were occasional along Catfish Creek as were the barnyard grasses *Echinochloa crusgalli* and *Echinochloa Walteri*. Sacciolepis (*Sacciolepis striata*), which is listed as rare, was also present.

Keechie, Catfish and Beaver Creeks

Keechie Creek was examined as a result of the occurrence of an interesting marsh-swamp area caused by the presence of beaver dams. This marsh-swamp has not been disturbed to any great extent but the surrounding hardwood forest has been subjected to selective cuttings. The more prevalent tree species surrounding the wet areas were water oak, willow oak, southern red oak, blackgum and white ash (*Fraxinus americana*) (Table 2). Trees and shrubs associated with the marsh-swamp area were common buttonbush, black willow, water elm, box elder (*Acer negundo*), green ash (*Fraxinus pensylvanica*), wax myrtle, and sea-myrtle (*Baccharis halimifolia*). The more abundant herbaceous species were tearthumb (*Polygonum sagittatum*), St. John's-wort (*Hypericum Walteri*), yellow lotus (*Nelumbo lutea*), tuckahoe (*Peltandra virginica*), pickerel-weed (*Pontederia cordata*), arrowhead (*Sagittaria graminea*), duck potato (*Sagittaria latifolia*),

Table 2. Estimated abundance* of shrub and tree species associated with creek areas on the east side of the Trinity River.

Species	Keechie Creek	Sand Lake	Catfish Creek	Beaver Creek	Mitchell Creek	Indian Creek	Wildcat Creek	Turkey Creek	Walnut Creek	Cedar Creek
	Creek areas									
<u>Acer</u> <u>negundo</u>	O				O-F		R		O-F	R-O
<u>Acer</u> <u>rubrum</u>		O								
<u>Alnus</u> <u>serrulata</u>..................		R								
<u>Amorpha</u> <u>fruticosa</u>................										O
<u>Ascyrum</u> <u>hypericoides</u>............		O-LF	LA							
<u>Ascyrum</u> <u>stans</u>...................			R							
<u>Baccharis</u> <u>halimifolia</u>...........	LF						O			
<u>Betula</u> <u>nigra</u>....................	R	O	O-F	F						
<u>Bumelia</u> <u>lanuginosa</u>..............					O-F					R

Table 2. Continued

<u>Callicarpa</u> <u>americana</u>	O	R-O	R-O	R	F	F	O	O		
<u>Carpinus</u> <u>caroliniana</u>		O-LA	F-A	F						R-O
<u>Carya</u> <u>aquatica</u>	O	R	R-O	O	O	F	F-A	O	O	F
<u>Carya</u> <u>illinoinensis</u>					R-O					O
<u>Carya</u> <u>texana</u>		R-O		R	O					
<u>Carya</u> <u>tomentosa</u>			R							
<u>Catalpa</u> <u>speciosa</u>	R				O					
<u>Celtis</u> <u>laevigata</u>			R	R	F	O	A	O-F	F	O-F
<u>Celtis</u> <u>reticulata</u>						R			R-O	
<u>Cephalanthus</u> <u>occidentalis</u>	LF	F-A	LF		O		R			O
<u>Cercis</u> <u>canadensis</u>					F-A	F	O	O	R	
<u>Cornus</u> <u>Drummondii</u>					F	O	O		R	
<u>Cornus</u> <u>florida</u>	R	R		R	O-F					
<u>Crataegus</u> <u>crus-galli</u>					F					R
<u>Crataegus</u> <u>Marshallii</u>			R-O							
<u>Diospyros</u> <u>virginiana</u>	R	R	O-F		O	R	O-F	R		R
<u>Forestiera</u> <u>acuminata</u>										A
<u>Forestiera</u> <u>ligustrina</u>					R-O					

Table 2. Continued

Fraxinus americana	O					O		O		
Fraxinus pensylvanica	O	O-F		F-A	F	O-F	R	O	F-A	
Gleditsia triacanthos			R		F-A	F	O	R	R	O
Ilex decidua		R	O-F	R-O	F	A	F-A		O	R-O
Ilex opaca		R-O	R-O	O						
Ilex vomitoria	R	L-F	R-O	O-F	O			R-O		
Juglans nigra					F		R	R	O	
Juniperus virginiana	R	R	R	R	R	R	R		R	R
Liquidambar Styraciflua	O	O	F	O						
Maclura pomifera							R		O	
Melia azedarach					O				R	
Morus rubra	R-O		R	R	O-F	R	R-O	R	R	R-O
Myrica cerifera	R-O	LF	O	R						
Nyssa sylvatica	O	O-F	O	O						
Pinus taeda		R-O								
Planera aquatica	O-LF	F-A	LA	R-O						F-A

Table 2. Continued

Platanus occidentalis										R
Populus deltoides					R	R	R-O			R
Prosopis glandulosa					R					
Prunus mexicana					R		O			
Prunus serotina					R					
Quercus falcata	O			R					R	
Quercus incana	R									
Quercus lyrata		R	O-LA							R-O
Quercus marilandica		R								
Quercus nigra	F-A	O	F-A	F	F-A	O	F	O-F	O	R-O
Quercus phellos	O-F	F	R-O					R	R	R-O
Quercus Shumardii					O	R	O			
Quercus stellata				R	F	O	F		O	O
Rhamnus caroliniana			R							
Rhus copallina	L-F	R	R				O			
Rhus toxicodendron	L-A				R-O	A	A	R		F

Table 2. Continued

<u>Salix</u> <u>nigra</u>	R-O	R	O-F	R	L-F	R	O	R	R-O	F-LA
<u>Sambucus</u> <u>canadensis</u>							R			
<u>Sapindus</u> <u>Saponaria</u>					O		O			
<u>Sassafras</u> <u>albidum</u>	R-O	R								
<u>Symphoricarpus</u> <u>orbiculatus</u>					F				O-F	
<u>Taxodium</u> <u>distichum</u>		O-F	R							
<u>Tilia</u> <u>caroliniana</u>	O				O-F					R
<u>Ulmus</u> <u>alata</u>	R	R	R-O	R	F-A		O-F	R-O	F	R-O
<u>Ulmus</u> <u>americana</u>	R-O		R-O	R	F		O	O	O	R-O
<u>Ulmus</u> <u>crassifolia</u>					O-F	A	F-A	O	O-F	F
<u>Vaccinium</u> <u>arboreum</u>		O		R						
<u>Viburnum</u> <u>nudum</u>		R								
<u>Viburnum</u> <u>rufidulum</u>		R			O		A			
<u>Zanthoxylum</u> <u>Clava-Herculis</u>									R-O	

Table 2. Continued

*Abundance is based upon the following scale:

D - Dominant

A - Abundant

F - Frequent

O - Occasional

R - Rare

The letter "L" in front of any of the letters above indicates local abundance.

persicaria (Persicaria punctata) and the grasses Panicum gymnocarpon, Panicum rigidulum and Paspalum Urvillei. Soft rush (Juncus effusus), although it had finished flowering, was still observed.

Catfish and Beaver Creeks, as they meander towards the Trinity River, feed into Sand Lake which is composed in part of marsh and swamp areas. Beaver Creek terminated at Sand Lake whereas Catfish Creek continued on to the Trinity River. To the east of Sand Lake was a sandy upland area composed of woody species such as loblolly pine (Pinus taeda), post oak, black hickory, and sandjack oak. Some large sandjack oak were present, the largest having an index of 146. The state champion sandjack oak has an index of 162.

Woody tree species prevalent around the eastern margin of Sand Lake were blue beech, green ash, water elm, water oak, willow oak, and bald cypress (Taxodium distichum) (Table 2). St. Peter's wort (Ascyrum hypericoides), common buttonbush, yaupon (Ilex vomitoria), wax myrtle, and farkleberry were common shrubs (Table 2). Herbaceous species such as the climbing hemp-weed (Mikania scandens), the cinnamon fern (Osmunda cinnamonea) and the royal fern were locally frequent to abundant. The sedge, Carex intumenscens and St. John's wort (Hypericum Walteri) were prevalent along the shore-line.

Sand Lake was a shallow lake characterized by the pre-

sence of small islands of soil. As a result, the lake was vegetated over much of its area resulting in a varied local flora. Small trees of bald cypress, water elm, overcup oak and water oak were prevalent on the soil islands as was the shrub, common buttonbush. These islands of soil were also densely covered with herbaceous species. Locally abundant populations of Persicaria (<u>Persicaria densiflora</u> and <u>Persicaria punctata</u>) were present. Plants of beggar-tick (<u>Bidens discoidea</u>), seedbox (<u>Ludwigia uruguayensis</u>), water-horehound (<u>Lycopus rubellus</u>), St. John's-wort (<u>Hypercium Walteri</u>) and water-feather (<u>Myriophyllum brasiliense</u>) were common along with the grasses <u>Leersia lenticularis</u>, <u>Panicum dichotomiflorum</u>, <u>Paspalum Urvillei</u>, <u>Sacciolepis striata</u> and <u>Erianthus stictus</u>. Yellow cow-lily (<u>Nuphar luteum</u>) covered fairly large areas of the lake.

The woody vegetation along Catfish Creek, as it leaves Sand Lake and continues westward, was dominated by trees such as river birch, blue beech, persimmon (<u>Diospyros virginiana</u>), sweetgum, water elm, overcup oak, water oak, and black willow. Prevalent shrubs were deciduous holly (<u>Ilex decidua</u>), wax myrtle, common buttonbush and American beautyberry (Table 2). There were also some locally frequent populations of herbaceous species including Persicaria, marsh purslane (<u>Ludwigia palustris</u>), the flatsedge, <u>Cyperus polystachyos</u> and false-nettle.

The most common tree species along Beaver Creek were blue beech, river birch, sweetgum, blackgum, water oak, and water hickory. Some parts of the creek contained a more upland type of vegetation with such representatives present as American holly (Ilex opaca), flowering dogwood, yaupon, southern red oak, black hickory and post oak.

The woody vegetation in and around Sand Lake and Keechie, Beaver and Catfish Creeks was generally characteristic of creek and bottomland vegetation in east Texas (Bray, 1906; Tharp, 1939; Chambless, 1971; Raines, 1971; and Sullivan and Nixon, 1971).

Mitchell, Indian, Wildcat, Turkey, Walnut and Cedar Creeks

Gently rolling hills occur in the vicinity of these creeks, but the topography associated with creek channels was generally flat. The creeks were small and contained little water with the exception of Cedar Creek, and had channels averaging 5 to 10 feet in depth and 10 to 15 feet in width. Cedar Creek which is one of the principal tributaries of the Trinity River, averaged about 10 to 15 feet in depth and 20-30 feet in width. Stream flow in lower Cedar Creek was regulated as a result of its present origin from Cedar Creek Reservoir. Turkey Creek was also regulated by a reservoir in its upper reaches. Only stagnant pools of water were present in this creek during our visit.

Woody vegetation was generally restricted to streamside areas due to the clearing of adjacent land for pasture and other uses. Cedar Creek, with its wider floodplain was generally more heavily wooded than the other creeks. It appeared that all of the creekside forested areas visited had been subjected to selective cuttings. As a result, no trees of significant size were observed. The most abundant trees along these creeks were water hickory, Texas sugarberry, redbud (*Cercis canadensis*), green ash, honey locust (*Gleditsia triacanthos*), water oak, black willow, winged elm (*Ulmus alata*) American elm and cedar elm (Table 2). American beautyberry, roughleaf dogwood (*Cornus Drummondii*), deciduous holly and poison ivy were prevalent shrubs. Vine species which were occasional to locally frequent included wild grapes (*Vitis spp.*), green-briers (*Smilax spp.*), supplejack (*Berchemia scandens*), pepper-vine (*Ampelopsis arborea*) and trumpet honeysuckle (*Campsis radicans*).

Herbaceous species were generally like those found along the margins of Keechie, Beaver and Catfish Creeks. Persicaria (*Persicaria hydropiperoides*) was locally occasional and elephants-foot (*Elephantopus carolinianus*) was generally occasional throughout. Prairie grasses, including some of the bluestems (*Schizachyrium* and *Andropogon spp.*) and grama grasses (*Bouteloua spp.*) were present in openings near the creeks.

The woody flora of these creek areas was generally characteristic of the woody flora of east Texas. There were a few species present, however, which are generally absent or rare in the more eastern forests of Texas. These include Forestiera (*Forestiera ligustrina*), netleaf hackberry (*Celtis reticulata*), and honey mesquite (*Prosopis glandulosa*) (Correll and Johnston, 1970).

Creek Areas (West Side of Trinity River)

Creeks studied on the west side of the Trinity River in connection with the proposed Tennessee Colony Lake are listed in Table 3 and range geographically from Big Brown Creek at the southern extreme north to Indian Creek (Fig. 2). The creeks are generally deeper, wider, longer and have more extensive bottomland areas than those covered on the east side. Richland Creek, which is one of the major tributaries of the Trinity River would be inundated approximately 16 miles (not creek miles) from its junction with the Trinity. All of the forested areas in connection with these creek bottoms have been subjected to selective cuttings at one time or another. There are, however, some large trees at certain sites. Reference should be made to Tables 8 and 9 for scientific and common names of plant species.

Indian, Rush and Alligator Creeks

Indian Creek, because of the presence of some large trees, was one of the more interesting creek areas visited.

Table 3. Estimated abundance* of shrub and tree species associated with creek areas on the west side of the Trinity River.

Species	Indian Creek	Rush Creek	Alligator Creek	Lower Chambers Creek	Upper Chambers Creek	Lower Richland Creek	Upper Richland Creek	Lower Tehuacana Creek	Upper Tehuacana Creek	Cottonwood Creek	Prairie Creek	Big Brown Creek
	Creek areas											
Acer negundo	F	F	O-F	O	R-O	O-LF	R-O	R	R-O	R	R	R-O
Amorpha fruticosa	R	R	R	R		R-O	R					
Ascyrum hypericoides ...											R-O	
Betula nigra												R-O
Bumelia lanuginosa		R	R		R-O		R-O	O	R		R	R-O
Callicarpa americana ...	R	R	R					R-O	R-O	R-O	F	
Carya aquatica					R			O	O	R	R	

Table 3. Continued

Carya cordiformis	R	R										
Carya illinoinensis	F	F	O-F	R-O	R-O	R	O-LF		O-F	R		O
Carya texana	R							R-O			R	R-O
Celtis laevigata	F-A	F	O	A	F-A	O-F	O-F	F	F-A	F	O	R-O
Celtis reticulata								R			R-O	
Cephalanthus occidentalis				R-O				R		L-F	R	R-O
Cercis canadensis	R	R	R		R	R	R-O	R-O		R-O	O	O
Cornus Drummondii	R	F	R	R-O	R-O	O-F	R-F		R		O	
Cornus florida											O	
Crataegus spp.			R	R	O	O	R-LF	R			R-O	
Crataegus viridis				O								
Diospyros virginiana ...		R			R	R	R	R-O	R	R	R	R
Euonymus atropurpureus .							R			R		
Forestiera acuminata ...	LF	LF		O	O	O	R-O	R	R-LF		R-O	
Forestiera ligustrina ..						R-O	R-LF	O-LF	R-F	O		O

Table 3. Continued

Fraxinus americana			O				R-O	R-O	R	R-O	R	R
Fraxinus pensylvanica ..	F-A	F-A	O	A	F-A	O-F	O-F	F	F	O-F	O-F	O
Gleditsia triacanthos ..	R	R	R-O	R	R-O	R	R-O	O-F	R-O	R-O		R
Ilex decidua	F-A	O	O-F	R-O	O	R-O	R-O	O-F	O	O	O	O
Ilex vomitoria		R-O					R	R-O	R-F	O	O	O
Juglans nigra	R	O	R-O						O	R		
Juniperus virginiana ...	R	R	R					R		O	R	R-O
Maclura pomifera	R		R	R	LF	R-O	O-LF	R	R-O			R
Melia Azedarach			R			R	R		R	R		R
Morus rubra	R-O	O	R-O	O	R-O	O	R-O	R	O	O	R	R
Planera aquatica	O-LA							R	R			
Platanus occidentalis ..	O	O										R
Populus deltoides	R-O	R	R	R	R		R			R	R	R-O
Prosopis glandulosa							R					
Prunus mexicana		R	R		R		R	R				
Prunus serotina	R										R	R

Table 3. Continued

Quercus alba											O	
Quercus falcata											R	
Quercus lyrata					O			R-O				
Quercus macrocarpa	R	O		O	O	O	R-O					
Quercus nigra	R	R	R-O				R	R-O	O-F	F	A	O
Quercus phellos	R							R-O		R-O		R
Quercus Shumardii	O	F	O	R	R	R-O	O-F	R-LF				
Quercus similis	R							R		R		
Quercus stellata	O	R	R				R	O			O-F	R
Rhamnus caroliniana		R										
Rhus copallina	R						R	R			R	
Rhus glabra		R										
Rhus toxicodendron		O		R	F-A	F	F-A	F	F	.	F	
Robinia Pseudo-Acacia ..												LF
Sabal minor	R						R	R-O	R	R		
Salix nigra	F-A	O	R	R-O	R-O	O-F	R-O	R	R	R-O	F	R-LO

Table 3. Continued

Sambucus canadensis					R				R		R	
Sapindus Saponaria	R	R	O-F	R-O	LF	F	R-O	R-LF	R		R	R-O
Sophora affinis				R			R	R	R	R	R-O	
Symphoricarpus orbiculatus	LO	F-A	O		O	O	LF	O	R-O	R	O-F	LF
Tilia caroliniana					R					R	R	
Ulmus alata		R-O			R			R-O	R		F	O-F
Ulmus americana	F	O	R	R-O	R-O	R	R-O	R	O-F	O	O	O
Ulmus crassifolia	F	O	F	F-A	A	F-A	F-A	F-A	O-A	F		
Viburnum rufidulum	R	R			R-O	R	R	R	R	R	R-O	
Zanthoxylum Clava-Herculis		R			R		R		R			

* Abundance is based upon the following scale:

D - Dominant

A - Abundant

Table 3. Continued

F - Frequent

O - Occasional

R - Rare

The letter "L" in front of any of the letters above indicates local abundance.

Reservoir water will back up Indian Creek about 2 1/2 miles from its junction with Rush Creek. Dominant trees along this creek, based on estimated abundance, were box elder, pecan (Carya illinoinensis), Texas sugarberry, green ash, black willow, American elm and cedar elm (Table 3). It should be noted that bitternut hickory (Carya cordiformis) was first encountered at Indian Creek. Water elm and swamp privet (Forestiera acuminata) were locally frequent to abundant. The most prevalent shrub was deciduous holly. Vines were common in the area with common greenbrier, cat-brier, bristly green brier (Smilax hispida) and eardrop vine (Brunnichia ovata) being the most prevalent.

Fairly extensive populations of the sedges Carex cherokeensis and Carex crus-corvi were present, usually in the more open woodlands. Other herbaceous species often encountered in the area were agrimony (Agrimonia rostellata), Dicliptera (Dicliptera brachiata), rain-lily (Cooperia Drummondii), panic grass (Panicum hians) and pigeon-berry (Rivina humilus).

As mentioned earlier, there were many large trees in the Indian Creek area. Several large green ash trees were present, the largest having an estimated index of 202. The index for the state champion green ash tree is 185 1/2. The green ash tree on Indian Creek, therefore, is potentially a state champion, but it, in turn, was superseded by two larger

trees located during the course of this study on Rush Creek. Several large sycamore (Platanus occidentalis) trees existed with circumferences measuring from 13 to 16 feet. A black willow tree measured near 14 feet while an eastern cottonwood (Populus deltoides) measured over 17 feet in circumference. There were some large pecans (Carya illinoinensis) measuring from 11 to 15 feet in circumference. One large tree measured 17.1 feet in circumference but the trunk began to fork at the point of measurement. This tree had an estimated index of 369 compared to the state champion tree with an index of 359. A large Shumard red oak was also present which measured over 12 feet in circumference.

Rush Creek exhibited a more diverse topography with some rather high embankments occurring at certain sites along the creek. The water had eroded a deep creek channel exposing at times a sandstone or shale bedrock. This in turn resulted in the presence of large boulders in the creek channel giving the creek a rather unique aspect. The most abundant trees along Rush Creek were box elder, pecan, Texas sugarberry, green ash, black walnut (Juglans nigra), red mulberry (Morus rubra), sycamore, bur oak (Quercus macrocarpa) Shumard red oak, black willow, American elm and cedar elm (Table 3). The shrub layer was generally represented by plants of roughleaf dogwood, deciduous holly, poison ivy and coral-berry.

Elephant's foot, wild rye (Elymus virginicus) and Oplismenus (Oplismenus hirtellus) were fairly common herbaceous species in lower areas along the creek whereas hairy grama (Bouteloua hirsuta), Texas grama (Bouteloua rigidiseta), turnsole (Heliotropium tenellum) and scarlet pea (Indigofera miniata) were found on the higher banks.

It was mentioned earlier that two large green ash trees were located on Rush Creek and and that both had indexes greater than the present Texas champion. A green ash located in the central portion of Rush Creek had an estimated index of 242 and another located on lower Rush Creek below its confluence with Indian Creek had an estimated index of 269. The index for the state champion green ash tree is 185 1/2 so there should be little doubt about the larger Rush Creek tree superseding the present champion. A Hercules-club tree (Zanthoxylum Clava-Herculis) had an estimated index of 109 which is the same index as that of the state champion of that species. There were also large trees of sycamore, box elder, American elm, bur oak, Shumard oak and Texas sugarberry in the Rush Creek area.

Alligator Creek, which is a few miles south of Rush Creek, meanders through a rather flat topography. The woodlands have generally been cleared along the creek. The woody vegetation is similar to that of Indian and Rush Creeks (Table 3). There were a few fairly large pecans and Ameri-

can elms in this area.

Chambers and Richland Creeks

Chambers Creek is one of the larger creeks associated with the Tennessee Colony Lake area. Its floodplain is rather extensive and inundation would occur for some 9 miles (not creek miles) beyond its junction with Richland Creek (Fig. 2). Little difference occurred between the woody and herbaceous vegetation of upper, middle and lower Chambers Creek (Table 3). Because of the moist, flat bottomlands that occur, Texas sugarberry, green ash and cedar elm were abundant throughout. Swamp privet and soap berry persisted occasionally in local populations. Plants of bur oak, pecan, box elder, roughleaf dogwood, swamp privet, poison ivy, red mulberry, black willow and American elm were occasionally observed. Vines were occasional to abundant throughout with common ballon-vine (*Cardiospermum Halicacabum*) being one of the more prevalent.

Many herbaceous species were present in and around Chambers Creek. The more noticeable ones were pink smartweed (*Persicaria bicornis*), cocklebur (*Xanthium strumarium*), thoroughwort (*Eupatorium serotinum*), giant ragweed (*Ambrosia trifida*), marsh-elder (*Iva annua*), wild rye, aster (*Aster lateriflorus*), inland seaoats (*Chasmanthium latifolium*) and camphor-weed (*Pluchea camphorata*).

Richland Creek, which is one of the major tributaries of the Trinity River, contains the most extensive bottomland of all the creeks observed in this study (Fig. 2). The creek in its upper reaches is narrow and deep but as it flows toward the Trinity River, and is enlarged by the contents of Chambers Creek, the channel widens and may be over 100 feet wide in some areas. The bottomland area is flat and as a result is farmed in some areas. In most instances, however, it is used as pasture.

Woodlands are common along Richland Creek with green ash, Texas sugarberry and cedar elm being most prevalent (Table 3). Cedar elm was especially abundant in flat areas away from the creek. Box elder, black willow, pecan and Shumard oak appeared to be more closely associated with the immediate creek area. Local populations of roughleaf dogwood, hawthorn (Crataegus spp.), swamp privet, Forestiera (Forestiera ligustrina), osage orange (Maclura pomifera) and soap berry were scattered throughout. Poison ivy was generally prevalent as were local populations of coral-berry. Vines such as common green-brier, cat-brier, grape, supplejack, and trumpet-honeysuckle were frequently observed. Herbaceous species were generally similar to those mentioned in connection with Chambers Creek.

Many large trees were noted in the Richland Creek area ranging in circumference from 10 to 13 feet and representing

such species as bur oak, pecan, Shumard oak and American elm.

Tehuacana, Cottonwood, Prairie and Big Brown Creeks

Tehuacana Creek parallels the Trinity River for approximately 5 miles (not creek miles) and then makes a gradual turn to the east (Fig. 2). The creek would be inundated for approximately 20 miles. Cottonwood, Prairie and Big Brown Creeks enter Tehuacana Creek in its lower reaches. The bottomland area of Tehuacana Creek was generally narrower than the bottomlands of Richland and Chambers Creek. The topography was usually flat. The tree species which dominated Richland and Chambers Creek areas, namely green ash, Texas sugarberry and cedar elm, also dominated the Tehuacana and Cottonwood Creek bottomlands. Water oak and American elm were fairly frequent (Table 3). Common shrub species were American beautyberry, Forestiera (Forestiera ligustrina), yaupon, deciduous holly and poison ivy. Certain areas contained dense populations of shrub, vine, and tree species whereas other sites exhibited a more savannah-like vegetation. Herbaceous species were generally the same as those of other west side creek areas. Some of the less often observed species were thoroughwort (Eupatorium incarnatum), bloodleaf (Iresine rhizomatosa), white grass (Leersia virginica), yellow cress (Rorippa sessiliflora), prickly mallow (Sida spinosa), frostweed (Verbesina virginica), western ironweed (Vernonia

Baldwinii) and nimblewill muhly (*Muhlenbergia Schreberi*).

The largest tree in the Tehuacana Creek tract was a water oak with a circumference of over 14 feet. Big trees of cedar elm, green ash, American elm, water hickory and box elder were also represented. There were few large trees observed on Cottonwood Creek.

The topography adjacent to Prairie Creek was flat to rolling while that of Big Brown Creek was generally flat. The creeks were small and contained little water. Beaver were active on Prairie Creek creating some fairly extensive wet areas. Green ash, water oak and winged elm were frequent on both creeks, with winged elm being more prevalent on elevated sites (Table 3). Poison ivy and coral-berry were the most abundant shrubs. A few large water oaks were observed on Big Brown Creek, but other than that, no trees of noticeable size were seen.

Comparison of Woody Species of East-and West-Side Creeks

Woody species most representative of the vegetation of the west-side creeks of the Tennessee Colony Lake area were box elder, pecan, Texas sugarberry, roughleaf dogwood, green ash, swamp privet, Shumard oak, water oak, poison ivy, black willow, soap berry, coral-berry, American elm and cedar elm. Of these green ash, Texas sugarberry and cedar elm generally

emerged as dominants.

When comparing creekside vegetation on the west side of the Trinity River with that on the east, green ash, Texas sugarberry and cedar elm were dominant in both localities (Tables 2 and 3). Those species present in both areas which were more depictive of west-side creeks were box elder, bastard indigo (Amorpha fruticosa), gum bumelia (Bumelia lanuginosa), pecan, swamp privet, Forestiera (Forestiera ligustrina), osage orange, Shumard oak, soap berry, and coral-berry. Species which were more representative of east-side creeks were river birch, water hickory, flowering dogwood and water elm. Other species characteristic of both east and west-side creeks were fairly constant in their representation in both areas.

Species which were present on the east side but not observed on the west side were red maple, bald cypress, smooth alder, blue beech, American holly, mockernut hickory, sweet-gum, wax myrtle, blackgum, Sassafras, farkleberry and possum-haw. These species, however, do not appear to be restricted to the east side of the Trinity River. Kral (1955) listed red maple, smooth alder, sweetgum, wax myrtle, blackgum and farkleberry as being present in a wet area near Fairfield, Texas which is on the west side of the Trinity River. Bitter-nut hickory and burning bush (Euonymus atropurpureus) were observed only on the west side. Bitternut hickory is found

along creeks in east Texas (Raines, 1971) whereas burning bush is distributed mainly in north-central Texas (Correll and Johnston, 1970).

River Basin

The Trinity River displays a rather tortuous course within the proposed Tennessee Colony Lake area. The main channel of the river is narrow, relative to its paralleling floodplain. The bottomland area is generally flat although high bluffs and rolling hills occur at certain sites along the river. Woodlands are still typical in the bottomland area but large tracts of land have been cleared for crop production and pasture usage. The forested areas still in existence have all been subjected to selective cuttings at one time or another.

The woody vegetation of that part of the river floodplain connected with Tennessee Colony Lake was generally uniform in composition. The same species were dominant throughout. Species which were most abundantly represented were box elder, Texas sugarberry (oftentimes in locally abundant populations), hawthorn (*Crataegus spp.*), green ash, swamp privet, black willow, soap berry, cedar elm, pecan, honey locust, deciduous holly, coral-berry, gum bumelia, roughleaf dogwood and bur oak (Tables 4, 5, and 6). Common greenbrier, cat brier, pepper-vine and eardrop vine were often

locally abundant. The most prevalent herbaceous species were Aster (*Aster Eulae* and *Aster lateriflorus*) and wild rye grass. These species were abundant in forested areas. Forest openings were oftentimes dominated by marsh-elder (*Iva annua*).

Forested areas between Highways 85 and 31 were generally dominated by the same species (Table 4). These forests had been heavily cut in the past and certain woodlands adjacent to the river were recently cleared. There were no large trees observed. The largest woodland area between Highways 85 and 31 is located along the river just north of the overflow canal from Cedar Creek Reservoir, in the Sanders Creek-Twin Lakes area. The significance of this area is in its large size since its vegetative composition is essentially the same as that for other areas along the river.

Less than a mile south of the Highway 31 bridge, over the Trinity River (Site 10, Table 5), is a narrow strip of woodland paralleling the eastern side of the river, which exhibits some large trees. An American elm with a circumference of 14 feet and an estimated height of 100 feet had an index of 288 which is just 26 points less than the index for the state champion tree. Big trees of Shumard oak, bur oak and pecan, with circumferences ranging from 8 to 13 feet were also present. This area appeared to be one of the more undisturbed sites in the Trinity bottomland.

Table 4. Estimated abundance* of shrub and tree species in the Trinity River basin area between Highway 85 and Highway 31.

Species	Study sites (see Fig. 2)							
	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6	Site 7	Site 8
Acer negundo		R-O	R	R-O	R-O	F	O	O-LF
Amorpha fruticosa						R		
Bumelia lanuginosa		R-O	R-O			R-O		
Carya aquatica				R				
Carya illinoinensis	R	R-O		O	R		R-O	
Carya tomentosa	R							
Celtis laevigata	F	O-F	F	F-A	F	F	O-F	O
Cercis canadensis						O		
Cornus Drummondii				O	R-O	R-O		R-O
Crataegus spp.		O	O		O	F	O	R-O
Diospyros virginiana								R

Table 4. Continued

Forestiera acuminata	O	LF	LA		LF	LF	LF	LF
Fraxinus pensylvanica	F	F	O-F	F	O-F	O-F	F-A	F-A
Gleditsia triacanthos	F	R-O	O			R-O		O
Ilex decidua					R-O	O		
Juniperus virginiana								R
Maclura pomifera	O		R	O		R		R
Morus rubra	R	R	R	R	R-O	R	R	R
Platanus occidentalis						R-O		R
Populus deltoides	F	O	R-O				R-O	R
Quercus macrocarpa		R-O	R	R-O		R-O		R-O
Quercus nigra								R
Quercus Shumardii		R-O	R		O	R-O		R-O
Rhus toxicodendron	O							
Salix nigra	A	O	R				LA	LF
Sapindus Saponaria		O	O-F	O	O	O		O
Ulmus americana		R	R		R			R-O

Table 4. Continued

Ulmus crassifolia	R-O	F-A	A	F-A	F-A	F	F-A	A
Viburnum rufidulum						R		

*Abundance is based upon the following scale:

D - Dominant

A - Abundant

F - Frequent

O - Occasional

R - Rare

The letter "L" in front of any of the letters above indicates local abundance.

Table 5. Estimated abundance* of shrub and tree species in the Trinity River basin area between Highway 31 and Highway 287.

Species	Study sites (See Fig. 2)								
	Site 9	Site 10	Site 11	Site 12	Site 13	Site 14	Site 15	Site 16	Site 17
Acer negundo		O	F	O-F	R-O			O-F	R
Amorpha fruticosa				R		R		R	
Bumelia lanuginosa				O	F	R	R	R-O	R
Callicarpa americana	LA								O
Carya aquatica	O	R				O	O-F		
Carya illinoinensis	LF	O	O	O	R		R	R-O	O-F
Carya texana									F
Carya tomentosa	O								
Catalpa speciosa	O								
Celtis laevigata	F	R-O	F	O	F-A	O-F	F-A	O-F	O

Table 5. Continued

Celtis reticulata					O				
Cephalanthus occidentalis				R-LF	LF	O	R		
Cercis canadensis			R	O	O		R		R
Cornus Drummondii	O		O	R-O		R	R	F	O
Cornus florida	R				O				
Crataegus spp.	O			O-LF	A	O-LF	O-LA	R	R-LF
Diospyros virginiana						LF	R	R	R
Forestiera acuminata		LO	R	L-LA	F	LF	R-LA	R	LA
Forestiera ligustrina									R
Fraxinus americana		LF	R-O					R-O	O-F
Fraxinus pensylvanica	O	O	F	F-A	F-A	O-F	F	F	O-F
Gleditsia triacanthos		R	R	F-A	A	O-F	O-F	R	O
Ilex decidua		O		R		O	O-LA	O-LF	O
Ilex vomitoria	O				R-O				
Juglans nigra	R								O
Juniperus virginiana	R			R	R				R
Maclura pomifera	O		R	R				R	O

Table 5. Continued

Morus rubra	R	R-O	R-O	O	R	R	R	O	R
Planera aquatica						R			
Platanus occidentalis		R-O	R	R	R			R	
Populus deltoides	O-F	R-O	LF		R			R-O	
Prunus mexicana	R			R	R			R-O	R
Prunus spp.						LF			
Quercus lyrata		R	R		O	F	O-F		
Quercus macrocarpa		O	R-O	O-F	R		R	O	R
Quercus marilandica									R-O
Quercus nigra									R-O
Quercus phellos						R	R		R
Quercus Shumardii	R	O	LF				R	O-F	R
Quercus similis	R						O-F		
Quercus stellata	O								LF
Rhus copallina				R		R	R		
Rhus glabra	LF								
Rhus toxicodendron	F			R	O	F		F	O

Table 5. Continued

<u>Sabal</u> <u>minor</u>			R			O	O-A		
<u>Salix</u> <u>nigra</u>	F	O-LF	LF	R-O	O	LO	LF	O	LF
<u>Sapindus</u> <u>Saponaria</u>		R	R	R-O	F-A	O-F	R	O-F	R
<u>Sophora</u> <u>affinis</u>							R	R	
<u>Symphoricarpus</u> <u>orbiculatus</u>				LF	LF	R-LF		R-O	R-O
<u>Ulmus</u> <u>alata</u>									O
<u>Ulmus</u> <u>americana</u>		R-O	R-O	O-F		R		R	R
<u>Ulmus</u> <u>crassifolia</u>	O	O	F	O-F	A	F-A	F-A	F	
<u>Ulmus</u> <u>rubra</u>	R								
<u>Viburnum</u> <u>rufidulum</u>				R					R

*Abundance is based upon the following scale:

D - Dominant   O - Occasional

A - Abundant   R - Rare

F - Frequent

The letter "L" in front of any of the letters above indicates local abundance.

Although generally cleared for pasture usage, some large trees were left standing in the vicinity along the old river channel between Stephen's Ranch and Creslenn Park (Site 12, Table 5). This area is about halfway between the river bridges at Highways 31 and 287 (Fig. 2). Several large bur oaks were present with one measuring over 12 feet in circumference. A large Shumard oak measured near 14 feet in circumference and there were additional big trees of green ash, pecan, american elm and box elder.

A more heavily wooded area to the south of Stephen's Ranch (Sites 14 and 15, Table 5) was also characterized by the occasional presence of large trees. A big honey locust tree (*Gleditsia triacanthos*) was observed which had an estimated index of 158. The listed index for the state champion honey locust is 142 1/2. The Stephen's Ranch tree, therefore, is a potential state record. Bottomland post oak (*Quercus similis*), which is not listed in the registry of champion big trees in Texas, was represented by some large trees ranging in circumference up to 9.3 feet. Several big overcup and bur oaks were also measured.

A rather extensive forested area south of Wildcat Ranch (Site 23, Table 6) which is on the west side of the Trinity River between Highways 287 and 84, is interesting due to the frequent occurrence of bush palmetto. The area is dominated by trees of cedar elm, hackberry and green ash. Few large

Table 6. Estimated abundance of shrub and tree species in the Trinity River basin area between Highway 287 and Highway 84.

Species	Study sites (See Fig. 2)										
	Site 18	Site 19	Site 20	Site 21	Site 22	Site 23	Site 24	Site 25	Site 26	Site 27	Site 28
Acer negundo	LO	R		R		R-O					
Amorpha fruticosa				R			R				
Betula nigra								R			
Bumelia lanuginosa	R-O	R-O	R-O	R	O		R		R-O		R-O
Callicarpa americana								F			
Carya aquatica										O	O
Carya illinoinensis	R	R	R		R					O	O
Carya texana								O			
Celtis laevigata	O	O	F-A	R-O	F-A	A	F-A	R	O-F	O-LA	O-LA
Cercis canadensis							R	R			

Table 6. Continued

Cornus Drummondii	O	O	R-O		O	O-F	O	R			O
Crataegus crus-galli								R-O			
Crataegus glabriuscula				O							
Crataegus Marshallii	O										
Crataegus spp.	O	O-F	O-F		O	O	R-O		O-F	O	
Crataegus viridis										R-O	F
Diospyros virginiana								R		R	R
Forestiera acuminata	R	LO	LF	LA	R	LF-A	R		LF	LA	
Fraxinus americana		R	LO					R-O	O		
Fraxinus pensylvanica	O	O	O-F	O	O	O	O-F		R	A	F
Gleditsia aquatica										LO	
Gleditsia triacanthos	R-O	R	O	R	R	R	R-O	R			R-O
Ilex decidua	O	O-F	R-O	R	R	O-F	O-F	R-O	R-O		LF
Ilex vomitoria					R			R			
Juniperus virginiana								R			
Maclura pomifera	R	R									

Table 6. Continued

<u>Morus</u> <u>rubra</u>	R		R-O	R	O	R-O	R-O	R			
<u>Myrica</u> <u>cerifera</u>								LF			
<u>Nyssa</u> <u>sylvatica</u>								LO			
<u>Pinus</u> <u>echinata</u>								R			
<u>Pinus</u> <u>taeda</u>								F-A			
<u>Platanus</u> <u>occidentalis</u>		R	R								
<u>Populus</u> <u>deltoides</u>	R-O										
<u>Prunus</u> <u>mexicana</u>		R						R			
<u>Quercus</u> <u>falcata</u>								O-F			
<u>Quercus</u> <u>lyrata</u>	R				O	R-O		R		O-LF	O-LF
<u>Quercus</u> <u>macrocarpa</u>	R-O	R-O	R-O	O	O	R	R		R-O	O	R-O
<u>Quercus</u> <u>marilandica</u>								O-F			
<u>Quercus</u> <u>nigra</u>								O			
<u>Quercus</u> <u>phellos</u>								R			R-O
<u>Quercus</u> <u>Shumardii</u>	R	R-O	R				R	R			
<u>Quercus</u> <u>similis</u>				R							O

Table 6. Continued

<u>Quercus</u> <u>stellata</u>								F			
<u>Rhus</u> <u>copallina</u>	F-A			R	R			R		R	
<u>Rhus</u> <u>glabra</u>								R			
<u>Rhus</u> <u>toxicodendron</u>			O-F	R	A						
<u>Sabal</u> <u>minor</u>	R					O-F	F-A				R
<u>Salix</u> <u>nigra</u>	LO	LO	LF	LF						LF	R
<u>Sapindus</u> <u>Saponaria</u>	R-O	R-O	R-O	R		R	O		O		
<u>Sophora</u> <u>affinis</u>	R	R	R		R-O						
<u>Symphoricarpus</u> <u>orbiculatus</u> ..		R-O						R			
<u>Tilia</u> <u>americana</u>							R				
<u>Ulmus</u> <u>alata</u>								O			
<u>Ulmus</u> <u>americana</u>			R-O	R	R-O			R			R-O
<u>Ulmus</u> <u>crassifolia</u>	F	F	A	F	F-A	A	F-A	R	F-A	F	F-A
<u>Vaccinium</u> <u>arboreum</u>								O			
<u>Viburnum</u> <u>rufidulum</u>								R			
<u>Zanthoxylum</u> <u>Clava-Herculis</u> ..								R			

Table 6. Continued

* Abundance is based upon the following scale:

D - Dominant

A - Abundant

F - Frequent

O - Occasional

R - Rare

The letter "L" in front of any of the letters above indicates local abundance.

trees exist in this area.

Further to the south bordering the west side of the river are some high bluffs characterized by the presence of loblolly and shortleaf pine (Site 25, Table 6). These bluffs are located near the northern boundary of the Coffield Unit of the Texas Department of Corrections. The high hills and steep slopes display a more diversified flora with winged elm, post oak, blackjack oak, loblolly pine and shortleaf pine occupying the drier sites and red oak, water oak, white ash, flowering dogwood and black gum generally occupying the lower slopes and ravines. Wax myrtle was locally frequent along a spring.

The last three sites studied were located in an extensive forested area, usually referred to as the "hardwood forest," which is situated a few miles to the north of the Highway 84 bridge over the Trinity River (Sites 26, 27, and 28, Table 6). The most prevalent woody species in the area were cedar elm, overcup oak, pecan, green ash, deciduous holly and hawthorn (Table 6). Trees other than pecan, with diameters greater than 18 inches had recently been cut but some large trees, probably of no commercial value, were left. These larger trees were generally overcup oak or green ash. The only observation of water locust (Gleditsia aquatica) in this study was made at this locality.

As was mentioned earlier, the more prevalent bottomland

species in the vicinity of Tennessee Colony Lake were box elder, Texas sugarberry, hawthorn, green ash, swamp privet, black willow, soap berry, cedar elm, pecan, honey locust, deciduous holly, coral-berry, gum bumelia, roughleaf dogwood and bur oak. Most of these species are characteristic of river bottoms in east and southeast Texas. Braun (1950) indicated that Texas sugarberry and cedar elm were generally distributed in bottomland forests of Texas, Louisiana and Arkansas. Green ash, deciduous holly, hawthorn, swamp privet, black willow, Texas sugarberry and honey locust were listed, although not in the same degree of abundance, as being present on a study site in the Angelina River bottom (Chambless, 1971) and on a bottomland site near the Neches River (Nixon, Chambless, and Malloy, unpublished data). The remaining species listed as prevalent in the Trinity River study area are generally widespread in their distribution with most being listed locally for central and east Texas (Vines, 1960; Correll and Johnston, 1970).

Significance of the Woody Vegetation

The total area of forestland in the United States is about 758 million acres. About 248 million acres are set aside in parks, etc., or are not suitable for growing commercial timber. Of the 510 million acres of commercial forest land, 28 percent is owned by the public and State and Federal

Governments. Forest products industry owns 13 percent and 59 percent is owned by private individuals (American Forest Institute, 1971).

In the Southern States, there are approximately 201,069,000 acres of commercial forest land (U. S. Department of Agriculture, 1965). Softwood types such as pines and firs comprise 80,609,000 acres whereas hardwood types including oaks, hickories, gums, elms, ash, cottonwood, birch and maple occupy 120,460,000 acres.

Forests of east Texas cover 11.5 million acres (61 percent) of the land in east Texas. Thirty-seven percent of the commercial forest land in east Texas is owned by the public or by industry. This land produces two-thirds of the softwood timber. Sixty-three percent is in private non-industrial ownership (U. S. Department of Agriculture, 1967).

Pine timber production in east Texas has risen significantly since 1955. Hardwood trends contrast greatly with those of pine in that production has decreased 11 percent since 1955 (U. S. Department of Agriculture, 1967). This decrease was especially noticeable in the large diameter size classes that are generally preferred for factory lumber and veneer. As a result, the destruction of hardwood forests due to water impoundments may become significant.

There were 94 woody species recorded in the Tennessee Colony Lake area (Table 8). All exhibit widespread distributional patterns in the United States with the exception of four species. Amorpha (*Amorpha paniculata*) and Eve's necklace (*Saphora affinis*) are restricted to Arkansas, Louisiana and Oklahoma in addition to their presence in Texas. Sea-myrtle (*Baccharis halimifolia*) is distributed in Texas, Louisiana, Arkansas and Florida. Hawthorn (*Crataegus glabriuscula*) is endemic in north-central and south Texas. It is likely that the hawthorn, *Crataegus warneri*, was also present within the study area although not recorded. Its type locality is Anderson County, Palestine, Texas (Sciscenti, 1971). This species is endemic to east Texas (Correll and Johnston, 1970).

Significance of Herbaceous Vegetation

A total of 376 herbaceous species were collected in this study from the Tennessee Colony Lake area (Table 9). Of these 376 species, Palafoxia (*Palafoxia reverchonii*), Aster (*Aster Eulae*), sunflower (*Helianthus debilis* var. *sivestris*), clammy-weed (*Polanisia erosa* subsp. *erosa*) and green-thread (*Thelesperma flavodiscum*) are endemic to Texas (Correll and Johnston, 1971). In the report assembled by Sciscenti (1971), *Astragalus leptocarpus*, *Astragalus sox-*

maniorum, *Coreopsis intermedia*, *Evax candida*, *Krigia gracilis*, *Mirabilis collina*, *Phlox Drummondii* var. *peregrina*, *Psoralea digitata* var. *parvifolia* and *Rubus deplaris* are possible endemics in the area. The significance, abundance and distribution of these Texas endemics will need to be determined through further investigation. Correll and Johnston (1970) have indicated that plants of the following species collected in this study are rare in Texas or in the vicinity of the Tennessee Colony Lake area: Windmill fingergrass (*Chloris verticillata*), flatsedge, (*Cyperus surinamensis*), beggar's ticks (*Desmodium Nuttalli* and *Desmodium obtusum*), narrow plumegrass (*Erianthus strictus*), mock pennyroyal (*Hedeoma Drummondii*), bog-rush (*Juncus trigonocarpus*), Virginia bugle-weed (*Lycopus virginicus*), beak-rush (*Rhynchospora capitellata*) and Sacciolepis (*Sacciolepis striata*). Detailed field studies will need to be made throughout the distributional ranges of these species in order to determine their significance in regard to the Tennessee Colony Lake area.

It is not likely that the compiled list of woody species located within the reservoir area during this study, would be greately enlarged as a result of spring and summer studies. Shrubs and trees are generally persistent throughout the regular growing season. Additional hawthorns (*Crataegus spp.*) could be determined and some species which

might have been overlooked or not encountered in this study could be detected. Herbaceous species, on the other hand, are usually ephemeral and spring and summer studies should add several hundred species to the list compiled in this study. It is imperative, therefore, that studies be carried out throughout the entire growing season (March to November) in order to determine content and significance of content of herbaceous species.

Rare and Endangered Species

Of the 23 rare and endangered plants associated with the east Texas forests and the Blackland Prairie, distributional patterns of bearded grass-pink (Calopogon barbatus), nutmeg hickory (Carya myristicaeformis), Carolina holly (Ilex ambigua) grass-of-parnassus (Parnassia asarifolia), Louisiana palm (Sabal louisiana), silky camellia (Stewartia malacodendron) and mullein foxglove (Dasistoma macrophylla) indicate the possible presence of these species in the proposed Tennessee Colony Lake area (Table 7). Of greatest concern among these species is the spring-flowering bearded grass-pink orchid. It is found in moist, sandy, acid soils on the edge of bogs, swamps and marshes and in moist open woodlands. Its only recorded occurrence is in Henderson County (Correll and Johnston, 1970). Based on location and

Table 7. Checklist* of rare and endangered plants in East Texas forests and Blackland Prairie

Species	Family	Common name
East Texas Forests		
Amelanchier arborea	Rose	Shadblow, serviceberry
Bartonia texana	Gentian	Texas Bartonia
Calopogon barbatus	Orchid	Bearded Grass-Pink
Carex granularis	Sedge	Meadow Sedge
Carex tenax	Sedge	Wire Sedge
Carya myristicaeformis	Walnut	Nutmeg Hickory, Bitter Waternut
Danthonia sericea	Grass	Downy Danthonia
Diarrhena americana	Grass	American Beakgrain
Dioclea multiflora	Legume	Boykin Clusterpea
Dryopteris cristata	True Fern	Crested Shield Fern
Ilex ambigua	Holly	Carolina Holly, Sand Holly

Table 7. Continued

<u>Lindera</u> <u>benzoin</u>	Laurel	Spicebush, Benjamin Bush
<u>Magnolia</u> <u>Ashei</u>	Magnolia	Ashe Magnolia
<u>Magnolia</u> <u>pyramidata</u>	Magnolia	Pyramid Magnolia
<u>Ophioglossum</u> <u>nudicaule</u>	Adder's Tongue	Fragile Adderstongue
<u>Parnassia</u> <u>asarifolia</u>	Saxifrage	Grass-of-Parnassus
<u>Psilotum</u> <u>nudum</u>	Clubmoss	Whiskfern
<u>Sabal</u> <u>louisiana</u>		Louisiana Palm
<u>Solidago</u> <u>auriculata</u>	Sunflower	Earleaf Goldenrod
<u>Stewartia</u> <u>malacodendron</u>	Camellia	Silky Camellia
Blackland Prairie		
<u>Dasistoma</u> <u>macrophylla</u>	Figwort	Mullein Foxglove
<u>Vernonia</u> <u>vulturina</u>	Sunflower	Buzzard Spring Ironweed
<u>Zizania</u> <u>texana</u>	Grass	Texas Wildrice

*From Rare Plant Study Center, P. O. Box 8495, Austin Texas.

Table 8 . Checklist of shrub and tree species within the proposed Tennessee Colony Reservoir area.

Scientific name	Common name
Acer negundo L.	Box elder
Acer rubrum L.	Red maple
Alnus serrulata (Ait.) Willd.	Smooth alder
Amorpha fruticosa L.	Bastard indigo
Amorpha paniculata T. & G.	Amorpha
Ascyrum hypericoides L.	St. Andrews Cross
Ascyrum stans Michx.	St. Peter's-wort
Baccharis halimifolia L.	Sea-myrtle
Baccharis neglecta Britt.	Roosevelt weed
Betula nigra L.	River birch
Bumelia lanuginosa (Michx.) Pers.	Gum bumelia
Callicarpa americana L.	American beautyberry
Carpinus caroliniana L.	Blue beech
Carya aquatica (Michx. F.) Nutt.	Water hickory
Carya cordiformis (Wang.) K. Koch	Bitternut hickory
Carya illinoinensis (Wang.) K. Koch	Pecan
Carya texana Buckl.	Black hickory
Carya tomentosa Nutt.	Mockernut hickory
Catalpa speciosa Worder	Catalpa
Celtis laevigata Willd.	Texas sugarberry

Table 8. Continued

Celtis reticulata Torr.	Netleaf hackberry
Cephalanthus occidentalis L.	Common buttonbush
Cercis canadensis L.	Redbud
Cornus Drummondii C. A. Mey.	Roughleaf dogwood
Cornus florida L.	Flowering dogwood
Crataegus crus-galli L.	Cockspur hawthorn
Crataegus glabriuscula Sarg.	Hawthorn
Crataegus Marshallii Eggl.	Parsley hawthorn
Crataegus spp.	Hawthorn
Crataegus viridis L.	Green hawthorn
Diospyros virginiana L.	Persimmon
Euonymus atropurpureus Jacq.	Burning bush
Forestiera acuminata (Michx.) Poir.	Swamp privet
Forestiera ligustrina (Michx.) Poir.	Forestiera
Fraxinus americana L.	White ash
Fraxinus pensylvanica Marsh.	Green ash
Gleditsia aquatica Marsh.	Water locust
Gleditsia triacanthos L.	Honey locust
Ilex decidua Walt.	Deciduous holly
Ilex opaca Ait.	American holly
Ilex vomitoria Ait.	Yaupon
Juglans nigra L.	Black walnut
Juniperus virginiana L.	Eastern red cedar

Table 8. Continued

Liquidambar Styraciflua L.	Sweetgum
Maclura pomifera (Raf.) Schneid	Osage orange
Melia azedarach L.	Chinaberry
Morus rubra L.	Red mulberry
Myrica cerifera L.	Wax myrtle
Nyssa sylvatica Marsh.	Black gum
Pinus echinata Mill.	Shortleaf pine
Pinus taeda L.	Loblolly pine
Planera aquatica (Walt.) J. F. Gmel	Water elm
Platanus occidentalis L.	Sycamore
Populus deltoides Marsh.	Eastern cottonwood
Prosopis glandulosa Torr.	Honey mesquite
Prunus mexicana Wats.	Mexican plum
Prunus serotina Ehrh.	Black cherry
Prunus spp.	Plum
Quercus alba L.	White oak
Quercus falcata Michx.	Southern red oak
Quercus incana Vartr.	Sandjack oak
Quercus laurifolia Michx.	Laurel oak
Quercus lyrata Walt.	Overcup oak
Quercus macrocarpa Michx.	Bur oak
Quercus marilandica Muench.	Blackjack oak
Quercus nigra L.	Water oak
Quercus phellos L.	Willow oak

Table 8 . Continued

Quercus Shumardii Buckl.	Shumard red oak
Quercus similis Ashe.	Bottomland post oak
Quercus stellata Wang.	Post oak
Rhamnus caroliniana Walt.	Indian cherry
Rhus aromatica Ait.	Fragrant sumac
Rhus copallina L.	Shining sumac
Rhus glabra L.	Smooth sumac
Rhus toxicodendron L.	Poison ivy
Robinia Pseudo-Acacia L.	Black locust
Sabal minor (Jacq.) Pers.	Bush palmetto
Salix nigra Marsh.	Black willow
Sambucus canadensis L.	American elder
Sapindus Saponaria L. var Drummondii (H. A.) L. Benson	Soap berry
Sassafras albidum (Nutt.) Nees.	Sassafras
Sophora affinis T. & G.	Eve's necklace
Symphoricarpus orbiculatus Moench.	Coral-berry
Taxodium distichum (L.) Rich.	Bald cypress
Tilia americana L.	American basswood
Tilia caroliniana Mill.	Carolina basswood
Ulmus alata Michx.	Winged elm
Ulmus americana L.	American elm
Ulmus crassifolia Nutt.	Cedar elm
Ulmus rubra Muhl.	Slippery elm

Table 8. Continued

Vaccinium arboreum Marsh.	Farkleberry
Viburnum nudum L.	Possum-haw
Viburnum rufidulum Raf.	Southern blackhaw
Zanthoxylum Clava-Herculis L.	Hercules-club

Table 9. Checklist of herbaceous and vine species within the proposed Tennessee Colony Reservoir area.

Scientific Name	Common Name
Acalypha gracilens Gray	Three-seeded Mercury
Acalypha ostryaefolia Ridd.	Three-seeded Mercury
Acalypha virginica L.	Three-seeded Mercury
Agalinis heterophylla (Nutt.) Small	Prairie Agalinis
Agalinis viridis (Small) Penn.	Green gerardia
Agrimonia parviflora Ait.	Agrimony
Agrimonia rostellata Wallr.	Agrimony
Agrostis perennans (Walt.) Tuckerm.	Autumn bentgrass
Amaranthus arenicola I. M. Johnston	Sandhills amaranth
Amaranthus cruentus L.	Purple amaranth
Amaranthus Palmeri Wats.	Pigweed
Ambrosia artemisiifolia L.	Short ragweed
Ambrosia psilostachya DC.	Western ragweed
Ambrosia trifida L.	Giant ragweed
Ammannia coccinea Rottb.	Tooth-cup
Ampelopsis arborea (L.) Koehne	Pepper-vine
Andropogon Gerardi Vitman	Big bluestem
Andropogon ternarius Michx.	Splitbeard bluestem
Andropogon virginicus L.	Broomsedge
Apios americana Medic.	American potato bean

Table 9. Continued

Aristida desmantha Trin. & Rupr.	Three-awn grass
Aristida lanosa Ell.	Three-awn grass
Aristida longespica Poir.	Three-awn grass
Aristida oligantha Michx.	Prairie three-awn
Arundinaria gigantea (Walt.) Muhl.	Giant cane
Asclepias obovata Ell.	Milkweed
Asclepias rubra L.	Milkweed
Asclepias viridiflora Raf.	Milkweed
Aster Eulae Shinners	Aster
Aster lateriflorus (L.) Britt.	Aster
Aster patens Ait.	Aster
Aster pratensis Raf.	Aster
Aster subulatus Michx.	Aster
Bacopa Monnieri (L.) Wettst.	Water-hyssop
Berchemia scandens (Hill) K. Koch	Rattan-vine, Supple-jack
Bidens bipinnata L.	Spanish-needles
Bidens discoidea (T. & G.) Britt.	Beggar-ticks
Bidens laevis (L.) B. S. P.	Beggar-ticks
Boehmeria cylindrica (L.) Sw.	False-nettle
Boerhaavia coccinea Mill.	Scarlet spiderling
Bothriochloa saccharoides (Sw.) Rydb.	Silver beardgrass
Bouteloua curtipendula (Michx.) Torr.	Side-oats grama

Table 9. Continued

Bouteloua hirsuta Lag.	Hairy grama
Bouteloua rigidiseta (Steud.) Hitchc.	Texas grama
Brunnichia ovata (Walt.) Shinners	Eardrop vine
Campsis radicans (L.) Seem.	Trumpet-honeysuckle, Cow-itch vine
Capsella Bursa-Pastoris (L.) Medic.	Shepherd's purse
Cardiospermum Halicacabum L.	Common balloon-vine
Carex cherokeensis Schwein.	Sedge
Carex crus-corvi Kunze	Sedge
Carex intumescens Rudge	Sedge
Carex Joorii Bailey	Sedge
Carex lurida Wahl.	Sedge
Cassia fasciculata var. rostrata (Woot. & Standl.) B. L. Turner	Partridge pea
Cassia obtusifolia L.	Sickle-pod
Chasmanthium latifolium (Michx.) Yates	Inland sea oats
Chasmanthium laxum (L.) Yates	Chasmanthium
Chasmanthium sessiliflorum (Poir.) Yates	Chasmanthium
Chenopodium ambrosioides L.	Mexican tea, wormseed
Chenopodium Berlandieri Moq.	Pitseed goosefoot
Chloris verticillata Nutt.	Windmill fingergrass
Cissus incisa (Nutt.) Des Moul.	Cow-itch

Table 9. Continued

Clematis crispa L.	Blue jasmine
Clematis Pitcheri T. & G.	Leather flower
Clitoria mariana L.	Butterfly pea, Pigeon-wings
Cocculus carolinus (L.) DC.	Red-berried moonseed
Commelina communis L.	Day-flower
Commelina diffusa Burm. F.	Day-flower
Commelina erecta L. var. *Deamiana* Fern.	Day-flower
Commelina virginica L.	Spiderwort
Conyza canadensis (L.) Cronq.	Horse-weed
Cooperia Drummondii Herb.	Rain-lily
Croptilon divaricatum (Nutt.) Raf.	Scratch-daisy
Croton capitatus Michx.	Hogwort, Woolly croton
Croton glandulosus L.	Croton
Croton Lindheimerianus Scheele	Croton
Croton monanthogynus Michx.	Prairie tea
Crotonopsis linearis Michx.	Rush-foil
Cuscuta compacta Juss.	Love-vine, Dodder
Cynodon Dactylon (L.) Pers.	Bermuda grass
Cyperus acuminatus T. & H.	Flatsedge
Cyperus brevifolius (Rottb.) Hassk.	Flatsedge
Cyperus erythrorhizos Muhl.	Flatsedge
Cyperus esculentus L.	Yellow nut-grass
Cyperus globulosus Aubl.	Flatsedge

Table 9. Continued

Cyperus Haspan L.	Flatsedge
Cyperus odoratus L.	Flatsedge
Cyperus ovularis var. cyclindricus (Ell.) Torr.	Flatsedge
Cyperus ovularis (Michx.) Torr. var. ovularis	Flatsedge
Cyperus polystachyos Rottb. var. texensis (Torr.) Fern.	Flatsedge
Cyperus pseudovegetus Steud.	Flatsedge
Cyperus retrofractus (L.) T. & G.	Flatsedge
Cyperus rotundus L.	Nut-grass
Cyperus setigerus T. & H.	Flatsedge
Cyperus strigosus L.	Flatsedge
Cyperus surinamensis Rottb.	Flatsedge
Desmodium Nuttallii (Schindl.) Schub.	Beggar's-ticks
Desmodium obtusum (Willd.) DC.	Beggar's-ticks
Desmodium paniculatum (L.) DC.	Beggar's-ticks
Desmodium sessilifolium (Torr.) T. & G.	Beggar's-ticks
Desmodium viridiflorum (L.) DC.	Beggar's-ticks
Dichanthium annulatum Stapf.	Dichanthium
Dicliptera brachiata (Pursh) Spreng.	Dicliptera
Digitaria adscendens (H. B. K.) Henr.	Southern crabgrass

Table 9. Continued

Digitaria diversiflora Swall.	Tropical crabgrass
Diodia teres Walt.	Poor joe, rough buttonweed
Diodia virginiana L.	Buttonweed
Dracopis amplexicaulis (Vahl) Cass.	Dracopis
Echinochloa colonum (L.) Link.	Jungle-rice
Echinochloa crusgalli (L.) Beauv. var. crusgalli	Barnyard grass
Echinochloa crusgalli (L.) Beauv. var. zelayensis (H. B. K.) Hitchc.	Barnyard grass
Echinochloa Walteri (Pursh) Heller	Echinochloa
Eclipta alba (L.) Hassk.	Eclipta
Eleocharis obtusa (Willd.) Schult.	Spikerush
Eleocharis tortilis (Link) Schult.	Spikerush
Elephantopus carolinianus Raeusch.	Elephant's-foot
Elephantopus tomentosus L.	Tobacco-weed, Devil's-grandmother
Elymus virginicus L.	Wild rye
Eragrostis curtipedicellata Buckl.	Gummy lovegrass
Eragrostis hirsuta (Michx.) Nees.	Lovegrass
Eragrostis hypnoides (Lam.) B. S. P.	Lovegrass
Eragrostis oxylepis (Torr.) Torr.	Red lovegrass
Eragrostis reptans (Michx.) Nees.	Lovegrass

Table 9. Continued

Erechtites hieracifolia (L.) Raf. var. intermedia Fern.	Fireweed, Burnweed
Erianthus giganteus (Walt.) Muhl.	Sugarcane Plumegrass
Erianthus strictus Baldw.	Narrow plumegrass
Erigeron strigosus Willd.	White-top
Eriocaulon decangulare L.	Pipewort
Eriochloa contracta Hitchc.	Prairie cupgrass
Eriogonum longifolium Nutt.	Wild Buckwheat
Eriogonum multiflorum Benth.	Wild Buckwheat
Eryngium Hookeri Walp.	Eryngo
Eryngium integrifolium Walt.	Eryngo
Erythrina herbacea L.	Coral Bean
Eupatorium coelestinum L.	Mist-flower
Eupatorium incarnatum Walt.	Thoroughwort, Boneset
Eupatorium perfoliatum L.	Thoroughwort
Eupatorium rotundifolium L.	Thoroughwort, Boneset
Eupatorium serotinum Michx.	Thoroughwort, Boneset
Euphorbia bicolor Engelm. & Gray	Snow-on-the-prairie
Euphorbia dentata Michx.	Spurge
Euphorbia maculata L.	Spurge
Euphorbia nutans Lag.	Eyebane
Euphorbia prostrata Ait.	Spurge
Euphorbia serpens H. B. K.	Spurge
Fimbristylis autumnalis (L.) R. & S.	Fimbristylis

Table 9. Continued

Fimbristylis Vahlii (Lam.) Link	Fimbristylis
Froelichia Braunii Standl.	Snake-cotton, Cotton-weed
Froelichia Drummondii Moq.	Snake-cotton, Cotton-weed
Fuirena simplex Vahl	Umbrella-grass
Fuirena squarrosa Michx.	Umbrella-grass
Gaura filiformis Small	Gaura
Gaura parviflora Hook.	Lizard-tail, velvet-leaf gaura
Gnaphalium obtusifolium L.	Cat-foot, fragrant cudweed
Gratiola brevifolia Raf.	Sticky hedge-hyssop
Hedeoma Drummondii Benth.	Mock Pennyroyal
Hedyotis nigricans (Lam.) Fosb.	Bluets
Hedyotis uniflora (L.) Lam.	Bluets
Helenium amarum (Raf.) Rock	Bitterweed
Helenium autumnale L.	Sneezeweed
Helianthus angustifolius L.	Sunflower
Helianthus debilis Nutt. subsp. _silvestris_ Heiser	Sunflower
Helianthus grosse-serratus Martens	Sunflower
Helianthus Maximiliani Schrad.	Maximilian sunflower
Heliotropium indicum L.	Turnsole
Heliotropium tenellum (Nutt.) Torr.	Turnsole

Table 9. Continued

Heterotheca latifolia Buckl.	Golden Aster, Camphor Weed
Heterotheca pilosa (Nutt.) Shinners	Golden Aster, Camphor Weed
Hibiscus lasiocarpos Cav.	Woolly rose-mallow
Hibiscus militaris Cav.	Scarlet Rose Mallow
Hibiscus trionum L.	Flower-of-an-hour
Hydrocotyle unbellata L.	Water-pennywort
Hydrocotyle verticillata Thunb. var. verticillata	Water-pennywort
Hydrolea ovata Choisy	Hydrolea
Hypericum mutilum L.	St. John's-wort
Hypericum Walteri Gmel.	St. John's-wort
Indigofera miniata Ort.	Scarlet pea
Ipomoea lacunosa L.	Morning Glory
Ipomoea pandurata (L.) Mey.	Wild potato
Ipomoea trichocarpa Ell.	Morning Glory
Iresine rhizomatosa Standl.	Bloodleaf
Iva angustifolia DC.	Marsh-elder, Sump-weed
Iva annua L.	Marsh-elder, Sump-weed
Juncus coriaceus Mack.	Rush, Bog-rush
Juncus effusus L.	Soft rush
Juncus repens Michx.	Rush, Bog-rush
Juncus trigonocarpus Steud.	Rush, Bog-rush
Justica lanceolata (Chapm.) Small	Lance-leaved water-willow

Table 9. Continued

Kallstroemia parviflora Nort.	Kallstroemia
Lactuca floridana (L.) Gaertn.	Lettuce
Leersia hexandra Sw.	Leersia
Leersia lenticularis Michx.	Catchfly grass
Leersia oryzoides (L.) Sw.	Rice cutgrass
Leersia virginica Willd.	White grass
Leptochloa filiformis (Lam.) Beauv.	Red sprangletop
Leptoloma cognatum (Schult.) Chase	Fall witchgrass
Lespedeza hirta (L.) Hornem.	Hairy bush clover
Lespedeza repens (L.) Bart.	Creeping bush clover
Lespedeza Stuevei Nutt.	Tall bush clover
Leucospora multifida (Michx.) Nutt.	Leucospora
Liatris elegans (Walt.) Michx.	Button-snakeroot, Blazing-star, Gay-feather
Liatris pycnostachya Michx.	Button-snakeroot, Blazing-star
Lindernia anagallidea (Michx.) Penn.	False Pimpernel
Lithospermum tuberosum A. DC.	Gromwell, Puccoon
Lobelia Cardinalis L.	Cardinal flower
Lonicera japonica Thumb.	Japanese honeysuckle
Lorinseria areolata (L.) Presl.	Chain fern
Ludwigia alternifolia L.	Seed-box, Rattle-box
Ludwigia decurrens Walt.	Primrose-willow

Table 9. Continued

Ludwigia leptocarpa (Nutt.) Hara.	Seedbox, Water-primrose
Ludwigia palustris (L.) Ell.	Marsh purslane
Ludwigia peploides (H. B. K.) Raven	Seedbox, Water-primrose
Ludwigia uruguayensis (Camb.) Hara	Seedbox, Water-primrose
Lycopus rubellus Moench	Water-horehound
Lycopus virginicus L.	Virginia bugle-weed
Manisuris rugosa (Nutt.) O. Ktze.	Joint-tail
Marshallia tenuifolia Raf.	Barbara's-buttons
Matelea gonocarpa (Walt.) Shinners	Matelea
Melothria pendula L.	Melonette
Micranthemum umbrosum (Walt.) Blake	Shade mud-flower
Mikania scandens (L.) Willd.	Climbing hemp-weed
Mimulus alatus Ait.	Monkey-flower
Mollugo verticillata L.	Indian chickweed
Muhlenbergia brachyphylla Bush	Muhly
Muhlenbergia Schreberi J. F. Gmel.	Nimblewill muhly
Myriophyllum brasiliense Camb.	Parrot's-feather, water-feather

Table 9. Continued

Nama hispidum Gray	Nama
Nelumbo lutea (Willd.) Pers.	Yellow lotus
Nothoscordum bivalve (L.) Britt.	Crow-poison
Nuphar luteum subsp. *macrophyllum* (Small) E. O. Beal	Yellow cow-lily, spatterdock
Onocleo sensibilis L.	Sensitive fern
Oenothera speciosa Nutt.	Showy primrose
Oplismenus hirtellus (L.) Beauv. subsp. *setarius* (Lam.) Mez	Oplismenus
Osmunda cinnamomea L.	Cinnamon fern
Osmunda regalis L. Var. *spectabilis* (willd.) Gray	Royal fern
Oxalis Dillenii Jacq.	Wood-sorrel, Lady's sorrel
Palafoxia Reverchonii (Bush) Cory	Palafoxia
Palafoxia rosea (Bush) Cory	Palafoxia
Panicum anceps Michx.	Panic grass
Panicum brachyanthum Steud.	Panic grass
Panicum dichotomiflorum Michx.	Fall grass
Panicum dichotomum L.	Panic grass
Panicum geminatum Forsk.	Panic grass
Panicum gymnocarpon Ell.	Panic grass
Panicum hemitomon Schult.	Maidencane
Panicum hians Ell.	Panic grass
Panicum rigidulum Nees.	Panic grass

Table 9. Continued

Panicum verrucosum Muhl.	Panic grass
Parthenocissus quinquefolia (L.) Planch.	Virginia creeper
Paspalum acuminatum Raddi	Paspalum
Paspalum dilatatum Poir.	Dallis grass
Paspalum floridanum Michx.	Paspalum
Paspalum fluitans (Ell.) Kunth	Paspalum
Paspalum laeve Michx.	Paspalum
Paspalum praecox Walt.	Paspalum
Paspalum pubiflorum Fourn.	Paspalum
Paspalum setaceum Michx.	Paspalum
Paspalum Urvillei Steud.	Vasey grass
Peltandra virginica (L.) Kunth	Tuckahoe
Penthorum sedoides L.	Ditch-stonecrop
Persicaria bicornis (Raf.) Nieuw	Pink smartweed
Persicaria coccinea (Muhl.) Greene	Persicaria
Persicaria densiflora (Meisn.) Moldenke	Persicaria
Persicaria hydropiperoides (Michx.) Small	Persicaria
Persicaria lapathifolia (L.) Small	Persicaria
Persicaria punctata (Ell.) Small	Water smartweed
Petalostemum candidum (Willd.) Michx.	Prairie Clover
Phoradendron villosum (Nutt.) Nutt. subsp. Coryae (trel.) Wiens	Mistletoe

Table 9. Continued

Phyla incisa Small	Texas frog-fruit
Phyla lanceolata (Michx.) Greene	Northern frog-fruit
Phyllanthus polygonoides Spreng.	Leaf-flower
Phyllanthus pudens Wheeler	Leaf-flower
Physalis angulata L.	Ground Cherry
Physalis angulata var. pendula (Rydb.) Waterfall	Ground Cherry
Physalis heterophylla Nees.	Clammy ground cherry
Physalis pubescens L. var. integrifolia (Dun.) Waterfall	Downy ground cherry
Physalis virginiana Mill.	Ground Cherry
Phytolacca americana L.	Pokeweed, pokeberry
Pluchea camphorata (L.) DC.	Camphor-weed
Pluchea foetida (L.) DC.	Stinking-fleabane
Pluchea purpurascens (Sw.) DC.	Stinkweed, Marsh-fleabane
Polanisia erosa (Nutt.) Iltis. subsp. erosa	Clammy-weed
Polygala cruciata L.	Milkwort, Polygala
Polygala ramosa Ell.	Milkwort, Polygala
Polygonum aviculare L.	Knotweed
Polygonum cristatum Engelm. & Gray	Knotweed, Smartweed
Polygonum sagittatum L.	Tearthumb, arrow-vine
Polygonum virginianum L.	Jump-seed
Pontederia cordata L.	Pickerel-weed
Potamogeton spp.	Pondweed

Table 9. Continued

Prionopsis ciliata (Nutt.) Nutt.	Prionopsis
Ptilimnium capillaceum (Michx.) Raf.	Mock Bishop's-weed
Ratibida columnaris (Sims.) D. Don	Mexican Hat
Rhexia mariana L.	Deer-grass, Meadow Beauty
Rhexia petiolata Walt.	Dear-grass, Meadow Beauty
Rhynchospora caduca Ell.	Beak-rush
Rhynchospora capitellata (Michx.) Vahl	Beak-rush
Rhynchospora corniculata (Lam.) Gray	Horned-rush
Rhynchospora glomerata (L.) Vahl	Beak-rush
Rivina humilis L.	Pigeon-berry, rouge-plant
Rorippa sessiliflora (Nutt.) Hitchc.	Yellow cress
Rotala ramosior (L.) Koehme	Tooth-cup
Rubus spp.	Bramble, Dewberry, Blackberry
Rudbeckia hirta L.	Brown-eyed Susan, Cone-flower
Ruellia caroliniensis (Walt.) Steud.	Ruellia
Ruellia humilis Nutt. var. *longiflora* (Gray) Fern.	Ruellia
Ruellia pedunculata Torr.	Ruellia

Table 9. Continued

Sacciolepis striata (L.) Nash	Sacciolepis
Sagittaria graminea Michx.	Arrowhead
Sagittaria latifolia Willd.	Duck potato, Wapato
Sagittaria montevidensis Cham. & Schlecht.	Arrowhead
Sagittaria platyphylla Engelm.	Arrowhead
Salvia azurea Lam.	Blue sage
Samolus parviflorus Raf.	Water-pimpernel, Brookweed
Saururus cernuus L.	Lizard's-tail
Schizachyrium scoparium (Michx.) Nash	Little bluestem
Scirpus cyperinus (L.) Kunth var. *rubricosus* (Fern.) Gilly	Bulrush
Sesbania Drummondii (Rydb.) Cory	Rattlebush, poison bean, coffee bean
Sesbania macrocarpa Muhl.	Sesbania
Sesbania vesicaria (Jacq.) Ell.	Bladder pod, Bag-pod
Setaria geniculata (Lam.) Beauv.	Setaria
Sida rhombifolia L.	Sida
Sida spinosa L.	Prickly mallow
Smilax Bona-nox L.	Cat-brier
Smilax hispida Muhl.	China-root, bristly green-brier
Smilax rotundifolia L.	Common green-brier

Table 9. Continued

Solanum americanum Mill.	American nightshade
Solanum carolinense L.	Carolina horse-nettle, ball-nettle
Solanum rostratum Dun.	Buffalo bur, Kansas-thistle
Solidago altissima L.	Goldenrod
Solidago nemoralis Ait.	Goldenrod
Solidago nitida T. & G.	Goldenrod
Solidago odora Ait.	Sweet goldenrod
Sorghastrum avenaceum (Michx.) Nash	Indian grass
Sorghum bicolor (L.) Moench	Sorghum
Sorghum halepense (L.) Pers.	Johnson grass
Sparganium androcladum (Engel.) Morong	Bur-reed
Spermacoce glabra Michx.	Smooth buttonweed
Spiranthes vernalis Engelm. & Gray	Spring ladies' tresses
Sporobolus asper (Michx.) Kunth	Tall-dropseed
Strophostyles helvola (L.) Ell.	Amberique bean
Strophostyles leiosperma (T. & G.) Piper	Slick-seed bean
Stylosanthes biflora (L.) B.S.P.	Pencil-flower
Teucrium canadense L. var. *canadense*	American germander, wood sage
Thelesperma flavodiscum (Shinners) B. L. Turner	Green-thread
Tillandsia usneoides (L.) L.	Spanish moss

Table 9. Continued

Tragia ramosa Torr.	Noseburn
Tribulus terrestris L.	Caltrop, puncture weed
Trichostema dichotomum L.	Forked blue curls
Tridens flavus (L.) Hitchc.	Purpletop
Tridens strictus (Nutt.) Nash	Tridens
Triplasis purpurea (Walt.) Chapm.	Purple sandgrass
Typha domingensis Pers.	Cat-tail
Utricularia gibba L.	Cone-spur bladderwort
Utricularia subulata L.	Bladderwort
Verbascum Thapsus L.	Flannel mullein, common mullein
Verbena bipinnatifida Nutt.	Small-flowered vervain
Verbena Halei Small	Texas vervain
Verbena urticifolia L.	White vervain
Verbena xutha Lehm.	Gulf vervain
Verbesina encelioides (Cav.) Gray	Cowpen daisy
Verbesina virginica L.	Frostweed
Vernonia Baldwinii Torr.	Western ironweed
Vernonia missurica Raf.	Ironweed
Vernonia texana (Gray) Small	Ironweed
Vitis aestivalis Michx.	Pigeon grape, Summer grape
Vitis Lincecumii Buckl.	Post oak grape
Vitis mustangensis Buckl.	Mustang grape

Table 9. Continued

Vitis rotundifolia Michx.	Muscadine
Vitis vulpina L.	Fox grape
Xanthium strumarium L.	Cocklebur
Xanthocephalum dracunculoides (DC.) Shinners	Broomweed, Snakeweed
Xanthocephalum texanum (DC.) Shinners	Broomweed, Snakeweed
Xyris iridifolia Chapm.	Yellow-eyed grass
Xyris Jupicai Rich.	Yellow-eyed grass
Zizaniopsis miliacea (Michx.) Doell & Asch.	Southern wildrice

habitat, plants of this species could be within the confines of the proposed lake.

Environmental Impact of the Tennessee Colony Reservoir on Vascular Plants

Impoundment studies covering woody and herbaceous vascular plants are scant. In addition, each impoundment is an entity unto itself with distinct climatic, edaphic, physiographic and biotic factors. To further complicate matters, the vegetation is only a particular part of the ecosystem. It acts as a modifier of the environment, an energy fixer, a source of minerals and a cycler of oxygen and carbon dioxide. The role of vegetation in the ecosystem must in turn be related to interactions among itself and with animals, micro-organisms, soils, topography, climate, etc. A full understanding of these interactions is not a short term task and, as a result, an explanation of the environmental impact of Tennessee Colony Lake in regard to vegetation would be highly speculative. It is very difficult, for example, to predict which plants would be affected and which plants might replace those that are lost. It is even more arduous to determine the overall effect on a particular ecosystem that the removal of a large tract of vegetation would cause. Nevertheless, an impact discussion will be

attempted concerning some of the more immediate effects on the vegetation in and around the proposed lake area.

Impact will in a sense depend upon the success or failure of individual plants. This, in turn, will affect the presence and composition of the various species in the Tennessee Colony Lake area. Obviously, most vascular plants within the confines of the reservoir would be destroyed. Impact would be greatest on rare and endangered species and on those species restricted to bottomland habitats. The more widespread species are often distributed in upland areas and loss of bottomland representatives would be less significant to their existence.

If woody and herbaceous plants are not destroyed prior to inundation, loss of those plants in the deeper waters would generally be rapid. Inundated plants in shallow water along the shore line would have a varied mortality depending on their tolerance to water. This would apply to both woody and herbaceous species.

Woody Vegetation

Bottomland woody species in shallow flooded areas such as might be present in the upper reaches of Catfish, Richland, Chambers and Tehuacana Creeks and the upper end of the reservoir within the floodplain of the Trinity River, will probably show variable survival patterns. Yeager (1949)

studied the effect of permanent flooding in a river-bottom timber area of Illinois. The species present were very similar to those associated with the Tennessee Colony Lake area. Some white ash plants were still alive after 8 years of inundation. Live representatives of water locust (Gleditsia aquatica) and black willow were present for 6 years. Plants of other species including American elm, pecan, persimmon (Diospyros virginiana), hawthorn, river birch, box elder, red mulberry, cottonwood, deciduous holly, bur oak, sycamore, flowering dogwood and redbud were all killed within a 6 year period. Green (1947) noted that American elm, green ash and black willow plants were still thriving after two years of inundation in 1 1/2 to 4 feet of water and that deciduous holly and swamp privet showed excellent growth in 1 to 5 feet of water for three years. River birch plants were dead and cottonwood trees were mostly dead within two years. Lake Chicot in Louisiana was studied by Eggler and Moore (1961) after 18 years impoundment. The basin area of the lake originally contained prevalent populations of bald cypress, tupelo gum (Nyssa aquatica), water elm and common buttonbush. The marginal portions supported upland vegetation. The lake, at the time of the Eggler and Moore study averaged 7 feet in depth. After eighteen years of inundation, 50% of the bald cypress trees and 28% of the tupelo gum trees had survived. All of

water elm and buttonbush plants had been killed. Marginal upland vegetation inundated to 2 feet had the following survival percentage: blue beech 0%, persimmon 5%, pecan 0%, sweetgum 3%, tupelo gum 100%, blackgum 0%, water oak 0%, overcup oak 50%, black willow 50%, and winged elm 0%. Bald cypress had increased by 383%. Studies by Hall and Smith (1955), Hosner (1958, 1960), Williston (1959), Hosner and Boyce (1962), Hosner and Leaf (1962) and Dickson, Hosner and Hosley (1965) have been made using seedlings experimentally and observing trees in nature in regard to tolerance of bottomland species to inundation. Some variations occurred among the results of these studies but in general bottomland species studied were arranged in the following order starting with the most water-tolerant and ending with the least water-tolerant species: water elm, black willow, common buttonbush, green ash, overcup oak, red maple, box elder, deciduous holly, cottonwood, sweetgum, hawthorn, willow oak, persimmon, honey locust, American elm, sugarberry, winged elm, sycamore, river birch, blue beech, Catalpa, water oak, blackgum, Shumard oak, Southern red oak, white oak, loblolly pine, smooth alder, eastern red cedar, American holly, Sassafras, flowering dogwood and black cherry. All these species were present in the Tennessee Colony Reservoir area and their post-impoundment survival in the shallow

shore-line locations could follow the above pattern. If the root crowns of these species continue to remain under water it is likely that all of these species would eventually die.

As was indicated earlier, the presence of bottomland hardwood species after impoundment would be restricted to the upper reaches of Creeks such as Catfish, Tehuacana, Richland and Chambers and to the upper non-flooded areas above the reservoir in the floodplain of the Trinity River. Maximum development of shore vegetation is generally dependent upon a stable water level. Since Tennessee Colony Lake will serve as a flood control project, water levels will fluctuate resulting in a zone of intermittently flooded land. The extent of this zone will be determined by topography. Bottomland species are generally subjected to periods of floodings and, therefore, most of the trees and shrubs present in the intermittently flooded bottomland areas should survive. The most notable change would probably be an increase along the shoreline of more water-tolerant species such as smooth alder, swamp privet and water elm. Studies by McDermott (1954) and Hosner (1959) indicated that seedlings of river birch, red maple, cottonwood, green ash and sycamore recovered rapidly after being subjected to periods of inundation.

In non-flooded bottomland shore areas, composition of

the woodland species should essentially remain the same. It is along steeper banks of the reservoir where transition and upland species occur that the greatest changes would probably be observed. Studies involving water-tolerance of upland species are lacking, but it is likely that those upland trees and shrubs near the waters edge would eventually be killed. Green (1947) found that plants of most species located two feet above water level were hardy after seven years impoundment. Some trees, however, did show a decrease in growth. Yeager (1949) observed that a three foot rise in water table along the margin of an impounded area, did not appear to affect the woody species present over an eight year period.

Although the vegetation of the higher shoreline areas might possibly remain the same, there is likely to be some changes in vegetative composition along the more immediate shoreline. Many interacting factors in a particular area affect such things as seed dissemination, migration, germination and seeding and plant development. Some of the more obvious are ground cover, litter, overstory, temperature, microbial activity, moisture, (including water table) and soil involving such soil factors as moisture holding capacity, chemistry, texture and structure. Because the Tennessee Colony Lake is in an area of convergence of two distinct

soil types, the sandy, acid soils characteristic of east Texas and the calcareous, basic soils representative of the Blackland Prairie, selective pressures on plants would be very contrasting.

If shoreline areas are allowed to vegetate naturally, seed dispersal becomes a significant factor. Seeds are generally dispersed by water, animals, wind and gravity. Immigration of new plants along the shoreline will generally be representative of species already present in the area. Fruits or seeds could roll down from upland sites and if the habitat is favorable, new plants could result. Animals especially birds, can carry seeds for variable distances. Seeds such as those from cottonwood and willow can be carried great distances by wind but wind dispersal of fruits from elm, ash and maple would generally be for short distances. Water could be an important dispersal agent in the Tennessee Colony Lake area. Fruits and seeds can be moved by water currents and are often washed upon the shore. In order to determine the tolerance of seeds to any lenthy stays in water, Hosner (1957) soaked seeds of red maple, American elm, sycamore, black willow and eastern cottonwood in water for 32 days. Results indicated that soaking in water does not inhibit seed germination of these species and, in fact, usually was advantageous. Vines (1960), Fowells (1965) and Correll and Johnston (1970) present in-

formation on seed dispersal regarding many of the shrub and tree species present in the Tennessee Colony Lake area. Among the 94 woody species recorded in the lake area, fruits and seed of 17 species were dispersed by water, 35 by animals other than birds, 35 by birds, 11 by wind and 16 by gravity. It should be noted that not all of the species recorded in the area were discussed by the above authors in regard to seed dispersal.

To imply as to which woody species would inhabit the shoreline areas of the reservoir is somewhat hazardous. Hosner and Minckler (1960) found that American elm, box elder and green ash competed effectively over a wide range of conditions whereas oaks and hickories seemed to require heavier soils with high moisture holding capacities. A look at the lake side vegetation of Sand Lake which is within the confines of the proposed reservoir might give some indication of the kinds of shrubs and trees which might inhabit the shores of Tennessee Colony Lake. Blue beech, river birch, farkleberry, loblolly pine, American holly, red maple, eastern red cedar (*Juniperus virginiana*), southern blackhaw (*Viburnum rufidulum*), sweetgum, overcup oak, water oak, willow oak, water elm, black hickory, blackgum, bald cypress, smooth alder, blackjack oak, flowering dogwood, yaupon, deciduous holly, wax myrtle, St. Andrews Cross

(*Ascyrum hypericoides*) and common buttonbush were present at Sand Lake. It is likely that these and other woody species would be present on the unflooded shoreline of Tennessee Colony Lake.

Additions to the woody vegetation around Tennessee Colony Lake could be made by planting exotic and native trees. This should be accomplished on the basis of habitat and a knowledge of environmental requirements of the particular species used. Silker (1948) indicated that reservoir margins can be revegetated by planting trees that grow naturally in wet areas.

Herbaceous Species

Herbaceous shoreline vegetation in bottomland sites should remain essentially the same. On steep slopes where transition and upland species previously occurred noticeable changes should transpire. Hydrophytic grass, sedge, rush and cyperus plants should become prevalent both in the intermittently flooded zone and near water in non-flooded areas. Plants of St. John's-wort and Persicaria should be common. Floating logs along the shore or possibly in other areas could contain plants of such species as beggars-ticks (*Bidens spp.*), seedbox (*Ludwigia spp.*), water-horehound and St. John's-wort in addition to grass, sedge, rush and cyperus plants. Herbaceous aquatics could become abundant after im-

poundment and have been known to cause serious problems in reservoirs. Eggler and Moore (1961) noted that after 20 months impoundment of Lake Chicot, Louisiana, fanwort (*Calomba caroliniana*) was abundant and that yellow lotus (*Nelumbo lutea*) and water-shield (*Brasemia shreberi*) were potential menaces. Four years after impoundment white water-lily (*Nemphaea odorata*) and common hornwort (*Ceroton-phyllum demersum*) were listed as abundant in patches. In later years, other species such as water-hyacinth (*Eichhornia crassipes*), alligator-weed (*Alternanthera philoxeroides*) and *Elodea densa* became locally abundant. All of these species are listed for the eastern half of Texas although only yellow lotus was found in the Tennessee Colony Lake area. It is feasible, therefore, that all of these species could eventually become established in the proposed reservoir. Yellow cow-lily (*Nuphar luteum*), water-feather (*Myriophyllum brasiliense*), tuckahoe (*Peltandra virginica*) and pondweed (*Potamogeton spp.*) are species listed from the reservoir area which could also become locally abundant in particular areas of the reservoir.

Rhoades conducted an inundation tolerance study in Oklahoma using 10 grass species. Correll and Johnston (1970) indicate that the distribution patterns of nine of these species encompass the Tennessee Colony Lake area. Thus, all nine

are potential shoreline species as a result of being initially present as a part of the prairie shoreline vegetation or as being introduced for erosional control or other uses. Bermuda grass (Cynadon dactylon), buffalograss (Buchloe dactyloides), vine-mesquite (Panicum obtusum), prairie cordgrass (Spartina pectinata) and a variety of switchgrass (Panicum virgatum) survived up to 20 days of inundation, another variety of switchgrass up to 15 days, big bluestem (Andropogon gerardi) up to 10 days and eastern grama grass (Tripsacum dactyloides), bluestem (Andropogon ischaemum) and weeping lovegrass (Eragrostis curvula) withstood inundation up to five days.

Zonation

Whenever an environmental factor, such as water, varies in intensity across the landscape, plants will respond based on their tolerance for this factor. As a result, increased distances from the water margin of a reservoir would generally result in a gradational decrease in water and in turn in vegetational changes. These changes in vegetation generally result in concentric zones of vegetation about the reservoir. The width of these vegetational zones and the composition of plants involved would vary not only in response to water (including wave action) but also as a result of factors such as existing vegetation, topography (degree

of slope) and soil. Given enough time, and if properly protected, the marginal areas of Tennessee Colony Lake should exhibit vegetational zonation. It should be kept in mind, however, that successional change of plant life resulting in zonation is a long-term process.

In bottomland situations around Tennessee Colony Lake, zonation will probably be less evident. Water elm, swamp privet and some grasses and sedges should be near the water line (Brown, 1943). Deciduous holly, green ash, hawthorn, and cedar elm are likely to be prevalent in bottomland areas short distances from the water line. Grasses and sedges and some forbs should be scattered throughout but unless openings are present, only occasional in their distribution.

Upland shorelines should contain rather dense populations of herbaceous hydrophytic plants as mentioned earlier in connection with shoreline vegetation. Small woody plants like common buttonbush might eventually become established. Willow and cottonwood plants could invade open shoreline areas and some woody plants might invade prairie areas near the reservoir where moisture changes are significant. In wooded areas trees such as sweetgum, blackgum, water oak, and flowering dogwood, etc. might occupy moist sites along the shoreline. The vegetational constitution of drier upland areas should remain essentially the same.

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ENVIRONMENTAL AND CULTURAL IMPACT. PROPOSED TENNESSEE COLONY RE--ETC(U)
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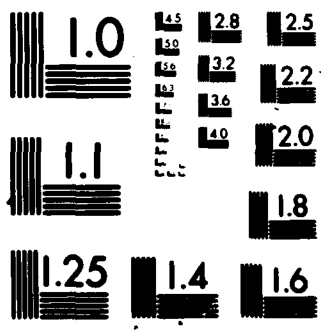

MICROCOPY RESOLUTION TEST CHART
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Impact predictions up to this point have been directed towards intial-and post-impoundment results. It is important, from the standpoint of vegetation, to discuss briefly the changes that might occur in the Trinity River-bottom in the vicinity of the proposed Tennessee Colony Lake if the reservoir was not constructed. Observations in the study area indicated that selective-and clear-cutting projects in the recent past have reduced and eliminated much of the bottomland forests in the proposed lake area. It is likely that a continued reduction in forested areas would take place in the future giving way to agricultural and livestock usage. As a result, complementary vegetational changes would occur resulting in a more open herbaceous type vegetation characteristic of farm and pasture areas.

Downstream Effects

The construction of Tennessee Colony Lake will undoubttedly affect the floodplain vegetation downstream from the dam-site area. Hydrophytic woody and herbaceous plants inhabiting wet flats and depressions in the floodplain of the river are likely to be destroyed or curtailed in growth if periodic flooding of these areas is eliminated. Plants associated with these flats and depressions are often-times dependent upon floods for surface and ground water recharge and for nutritional benefits from mineral and organic matter deposits.

CONCLUSIONS

1. The woody vegetation inhabiting upland, creekside and bottomland sites in and around the Tennessee Colony Reservoir was generally representative of the vegetation of east Texas. Of 94 species of woody plants recorded for the Tennessee Colony Lake area, only one was endemic to Texas. Concern for bottomland hardwood forests has become a necessity due to a recent 11% decrease in production over a ten year period. Large tracts of forested land have recently been cleared by landowners in the Tennessee Colony Lake area.
2. The fall herbaceous flora of the Tennessee Colony Reservoir area was characterized by the presence of five Texas endemics and nine species which are listed as rare. Spring and summer floras of the lake area would contain additional endemic and rare species including the grass-pink orchid which is listed only in Henderson County. Content and significance of content of herbaceous species can only be determined by consistant sampling for at least one year. Each study site should be visited every two weeks beginning in March and ending in November.
3. Several noteworthy ecological areas were observed during the course of this study. They are listed below and briefly discussed in regard to their signifi-

cance.

A. Keechie Creek contained a diverse flora, especially in swamp and marsh areas associated with the main creek channel. These wet areas were a result of beaver activity along the creek and were relatively undisturbed. A detailed year-long floristic study of certain areas along Keechie Creek should prove to be very rewarding.

B. The uniqueness of the Engeling Wildlife Habitat Management Area lies in its habitat diversity. Springs, marshes, swamps and bottomlands associated with Catfish Creek displayed a great variety of plant life. Detailed studies conducted throughout the growing season would reveal a distinct and interesting flora.

C. The Sand Lake area located at the confluence of Catfish and Beaver Creeks exhibited woody plants generally characteristic of east Texas. The shallowness of this lake, however, resulted in an interesting herbaceous flora, which, if studied year around could prove to be quite unique.

D. The almost certain presence of the state champion green ash tree and the possible occurrence of state champion trees of pecan and Hercules-club contributed to the significance of the Indian and Rush

Creek areas.

E. Upper Richland Creek was characterized by the presence of some fairly large trees.

F. The forested area along the Trinity River in the vicinity of horseshoe bend and Twin Lakes between Highways 85 and 31 was significant as a result of its large size.

G. A narrow belt of woodland on the east side of the Trinity River about one mile south of Highway 31 contained some large trees and appeared to be somewhat undisturbed.

H. A rather extensive forested area south of Stephens Lake between Highways 31 and 287 was characterized by some large trees including the occurrence of a possible state champion honeylocust tree.

I. The occurrence of a rather uniformly distributed population of bush palmetto in a forested area south of Wildcat Ranch along the Trinity River made this area somewhat unique.

J. Some high bluffs along the Trinity River near the northern boundry of the Coffield Unit of the Texas Department of Corrections were characterized by a diverse flora including loblolly and shortleaf pine.

K. Just a few miles north of the junction of Highway

84 and the Trinity River was an extensive hardwood forest. The significance of this area is in its size and the presence of some large trees.

RECOMMENDATIONS

1. If possible, the large trees located on Indian and Rush Creeks should be preserved.
2. Damsite 2A is recommended in order to protect the unique vegetation in connection with Keechie and Catfish Creeks and Sand Lake.
3. Floating and floating-leaved anchored vascular plants should be closely monitored if the reservoir is constructed. These plants, as a result of shading and other factors, can lower oxygen levels and can cause the elimination of submerged green plants.
4. If the reservoir is constructed, long term successional studies should be initiated in connection with shoreline vegetation. This would require the preservation of certain selected study sites on the margin of the reservoir.
5. Successional studies should also be established in the floodplain areas below the dam of Tennessee Colony Reservoir to determine the downstream effect of this reservoir on floodplain vegetation.

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